بســـم اللـــــه الرحمـــن الرحيـــم

2nd Civil Engineering

Second term

Chapter One : Moment Distribution

فى الجزء ده سيتم بمشيئة الله دراسة الـ internal force للمنشآت الغير محدده استاتيكا

استخدامات الطريقة :

- Introduction (1 sections).
- Beams (1 sections).
- Frames without side sway (1 sections).
- Frames with side sway (1 sections).

Chapter Two : Approximate Method

طريقة تقريبية لحساب الـ internal force for frames بطريقتين :

- Portal Frame (1 sections).
- Cantilever Method (1 sections).

Chapter Three : influence line for Ind Str

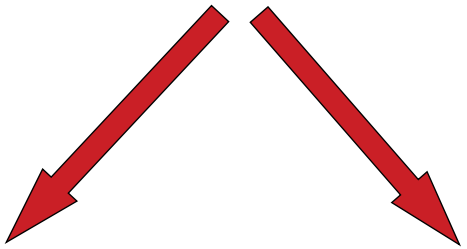
- Beams (1 sections).
- Frames (1 sections).
- Trussed Beam (1 sections).
- Multi Story with side sway (1 sections).

بســـم اللـــــه الرحمـــن الرحيـــم

Introduction to Determinate and indeterminate structures

مقدمة عن المنشآت المحدده والغير محدده استاتيكيا

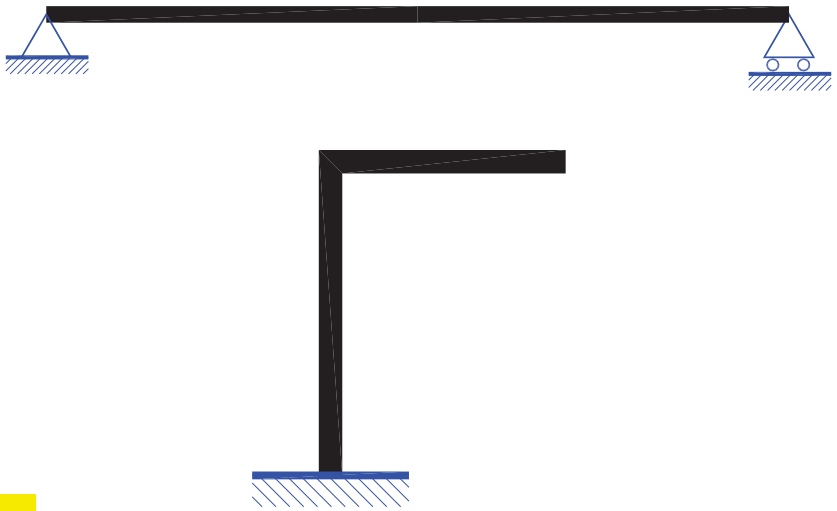
Structures المنشآت



Determinate
محددة استاتيكياً

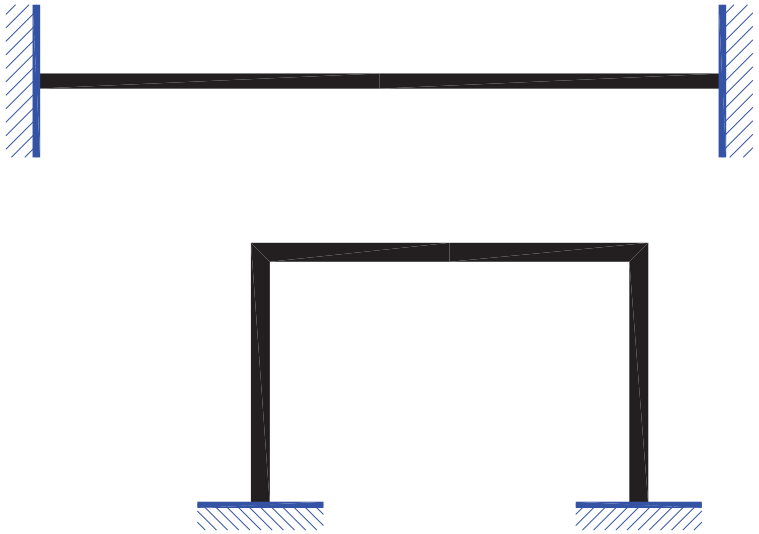
Indeterminate
غير محددة استاتيكياً

المنشآت المحددة استاتيكياً



5

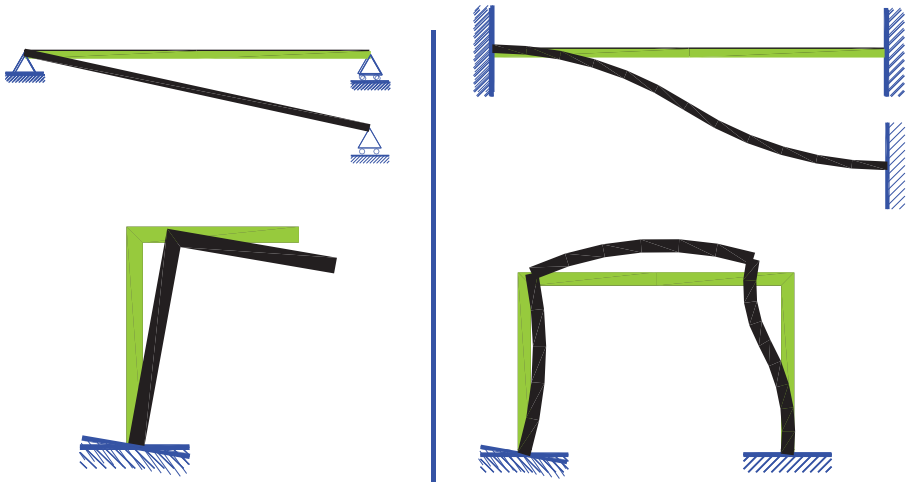
المنشآت الغير محددة استاتيكياً



6

Determinate | Indeterminate

Settlement

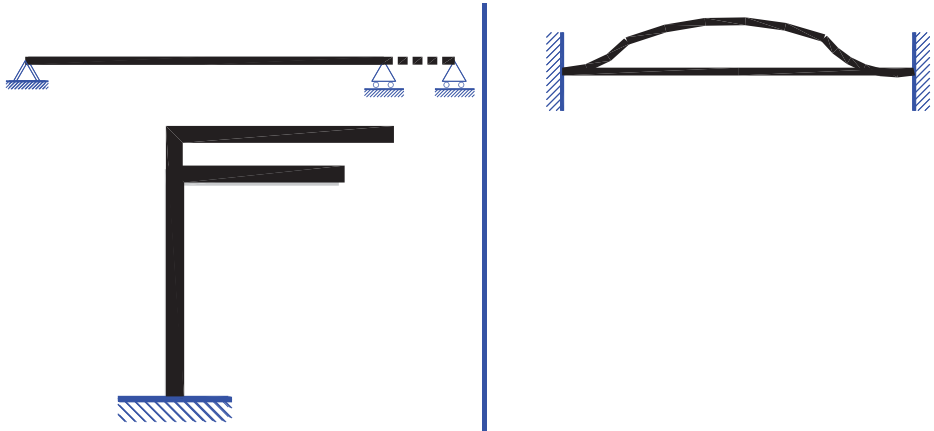


No Effect | Serious Effect

7

Determinate | Indeterminate

Temperature

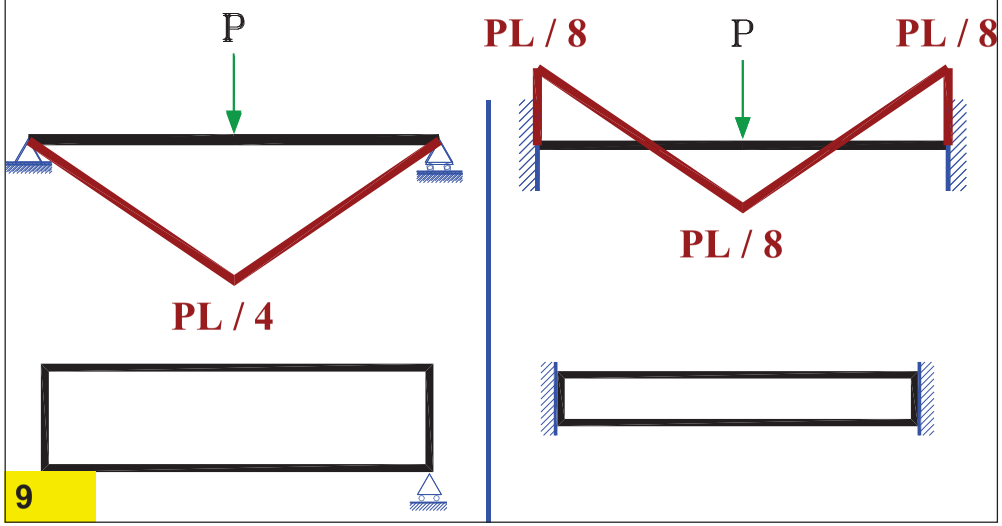


No Effect | Serious Effect

8

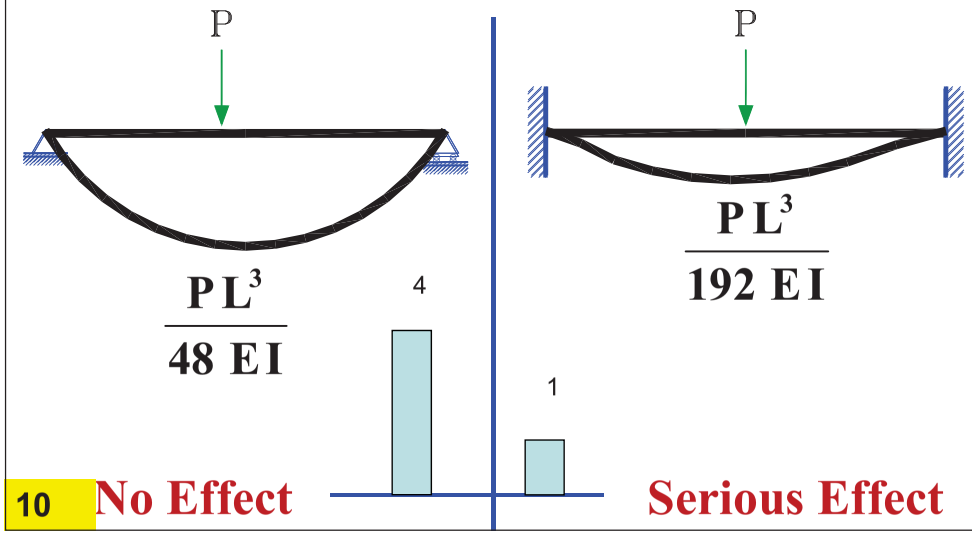
Determinate | Indeterminate

Moment



Determinate | Indeterminate

Deflection



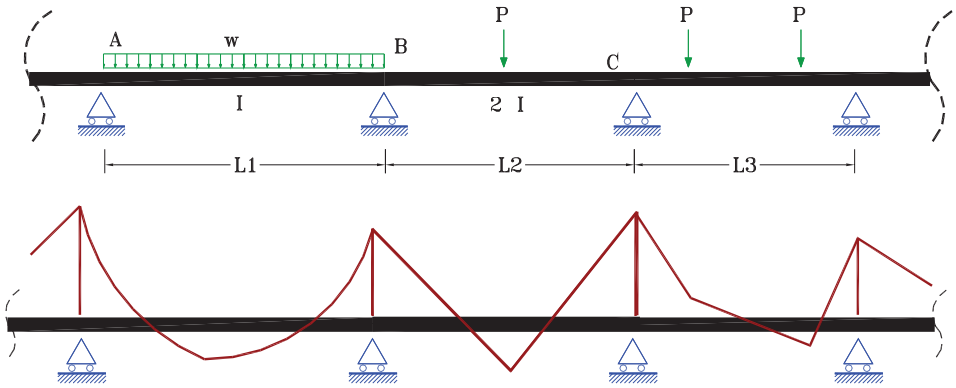
No Effect — Serious Effect

بسـم اللـه الرحمـن الرحيـم

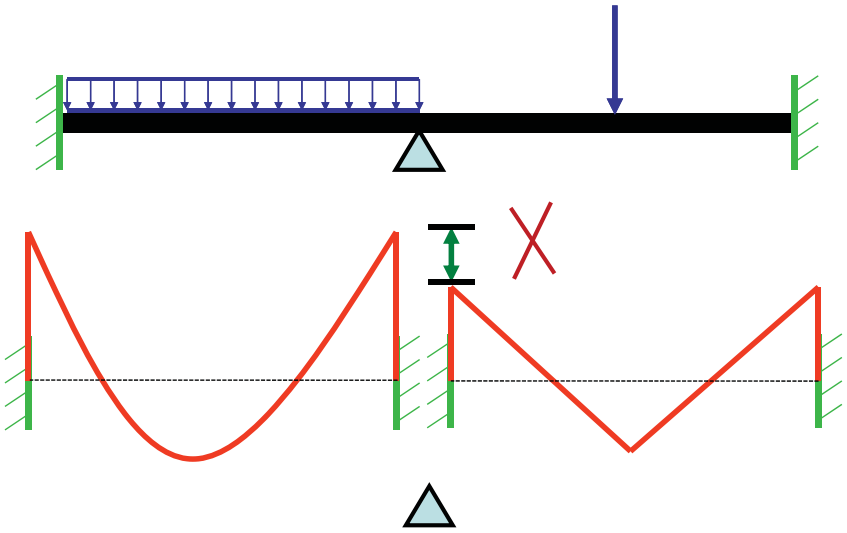
Moment Distribution

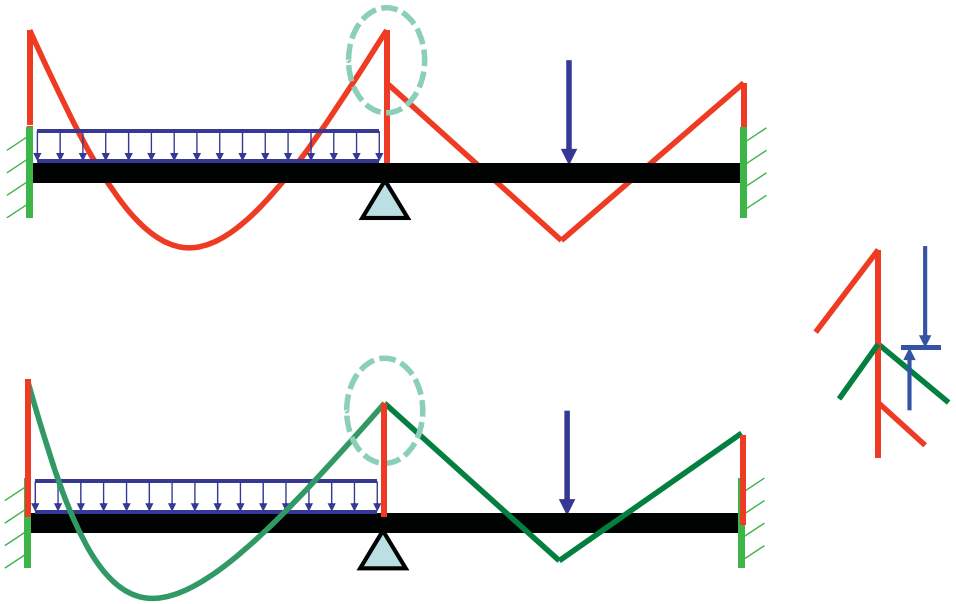
Beams

Introduction



Problem Formulation :

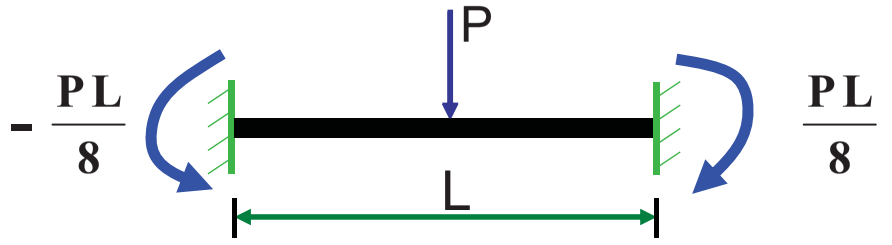




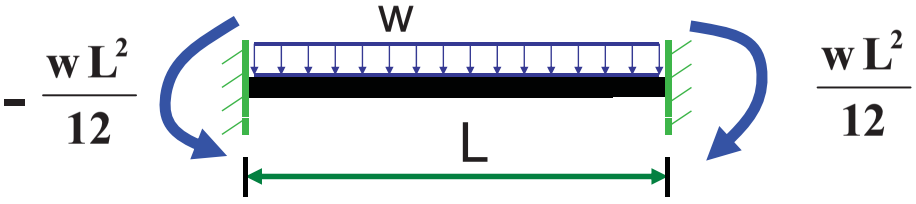
Solution Steps :

1. Fixed End Moment — FEM
2. Relative Stiffness — RS
3. Distribution Factor — DF
4. Table :
   - 4.1 Fixed End Moment
   - 4.2 Distribution Moment
   - 4.3 Carry Over Moment
   - 4.4 Distribution Moment

1. Fixed End Moment

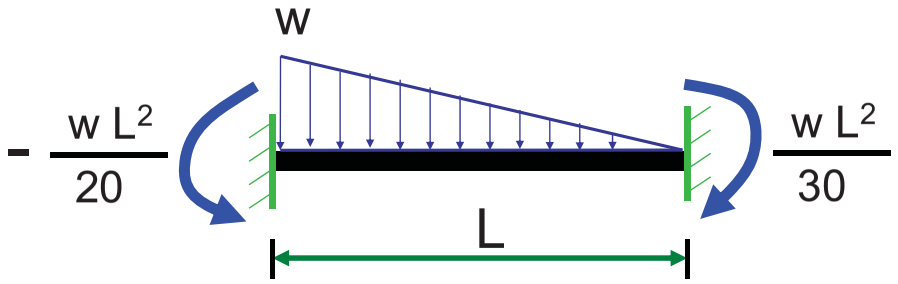


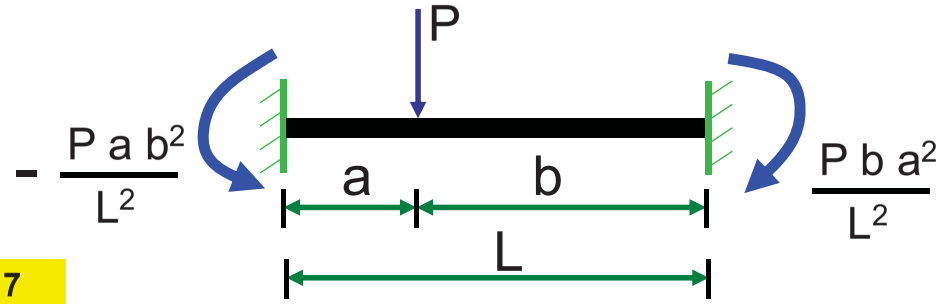
$$-\frac{PL}{8} \qquad \frac{PL}{8}$$



$$-\frac{wL^2}{12} \qquad \frac{wL^2}{12}$$

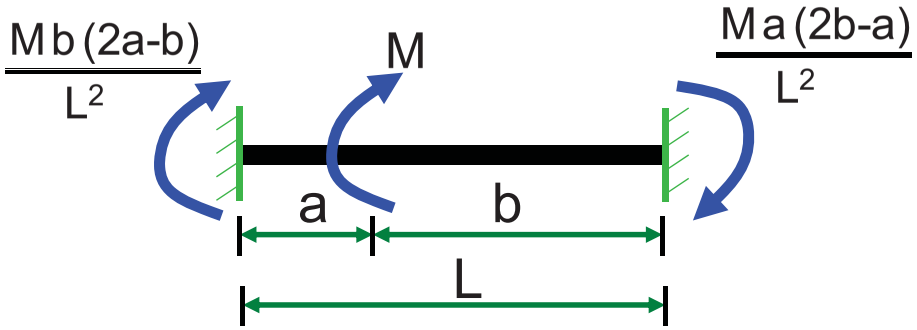
1. Fixed End Moment

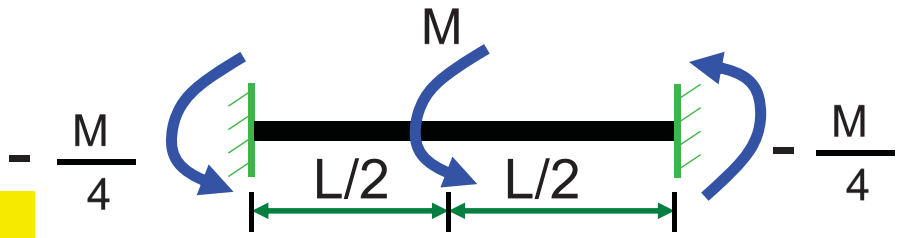




17

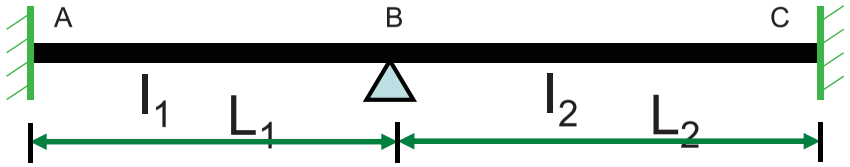
1. Fixed End Moment





18

2. Relative Stiffness



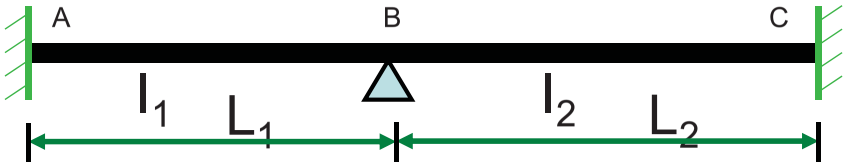
RS : $K_{AB} : K_{BC}$

$\frac{I_1}{L_1} : \frac{I_2}{L_2}$

$RS_1 : RS_2$

19

3. Distribution Factor



DF: AB : BC

$RS_1 : RS_2$

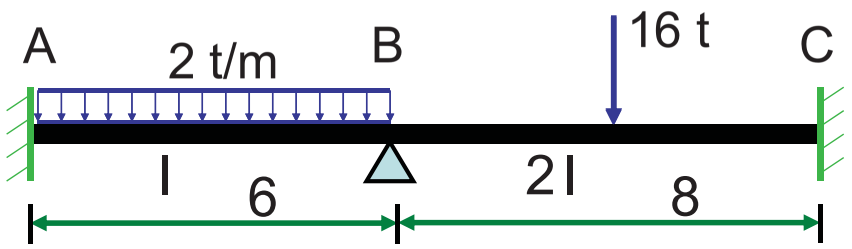
$\frac{RS_1}{RS_1 + RS_2} : \frac{RS_2}{RS_1 + RS_2}$

$DF_1 : DF_2$

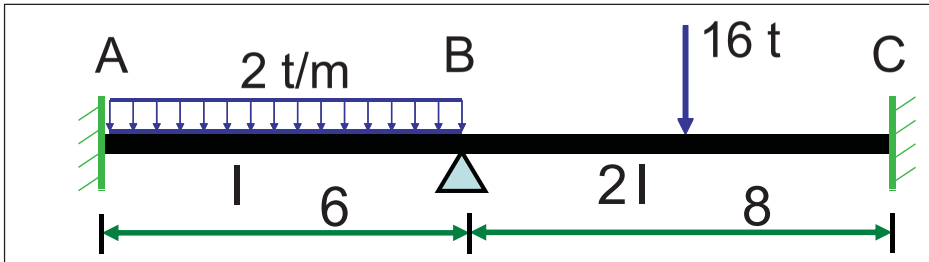
20

Example 1 :

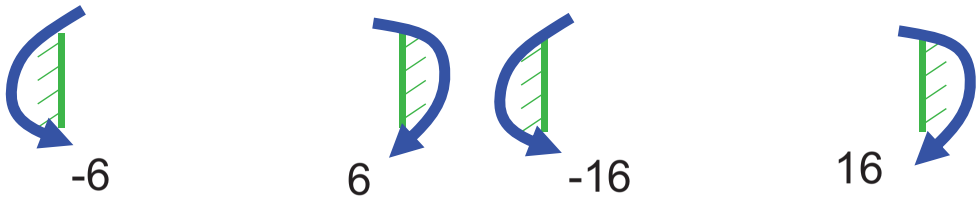
Draw B.M.D & S.F.D for the shown beam



21

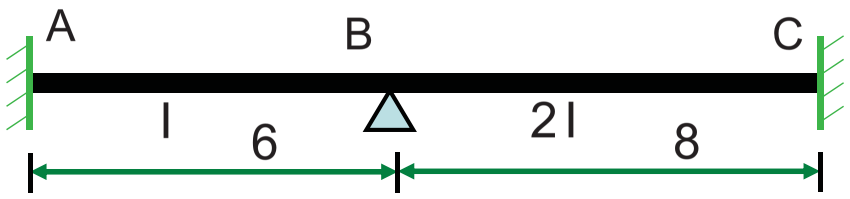


Fixed End Moment



$$M_{F_{AB}} = \frac{wL^2}{12} = \frac{2*6^2}{12} = 6 \qquad M_{F_{BC}} = \qquad M_{F_{CB}} = \frac{PL}{8} = 16$$

22



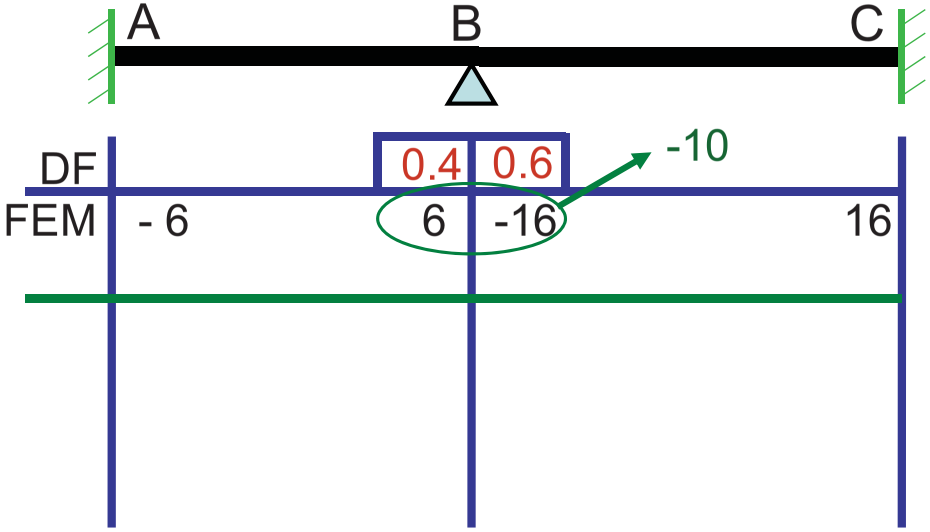
R.S

K_{AB}	:	K_{BC}
$\frac{1}{6}$	:	$\frac{2}{8}$
$\frac{1}{6}$	:	$\frac{1}{4}$
2	:	3

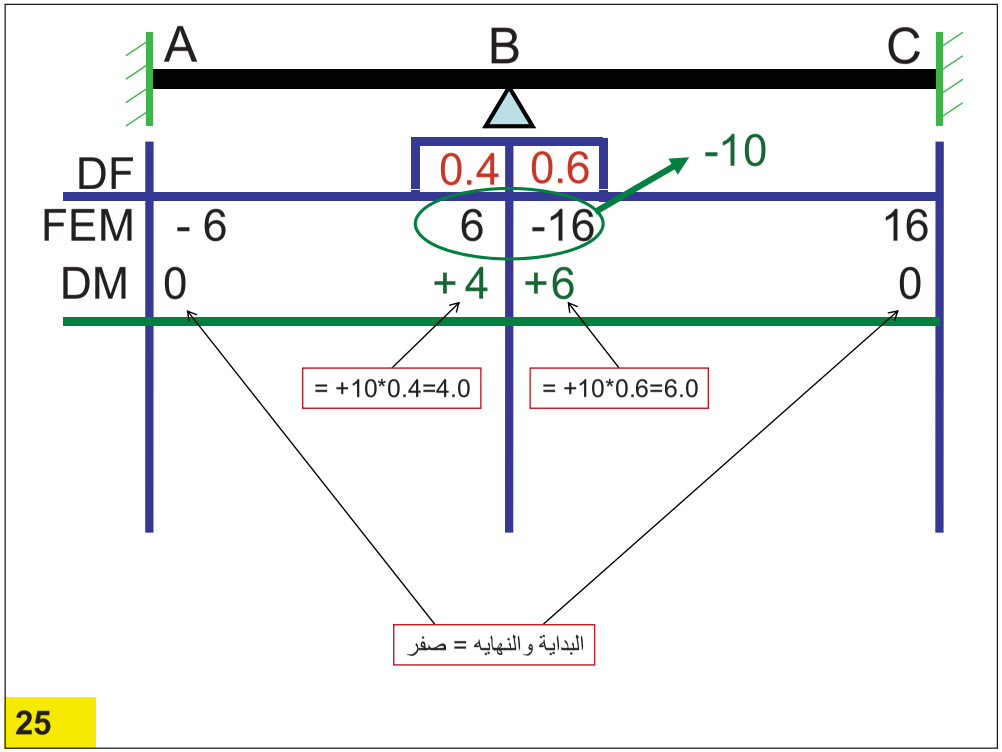
D.F

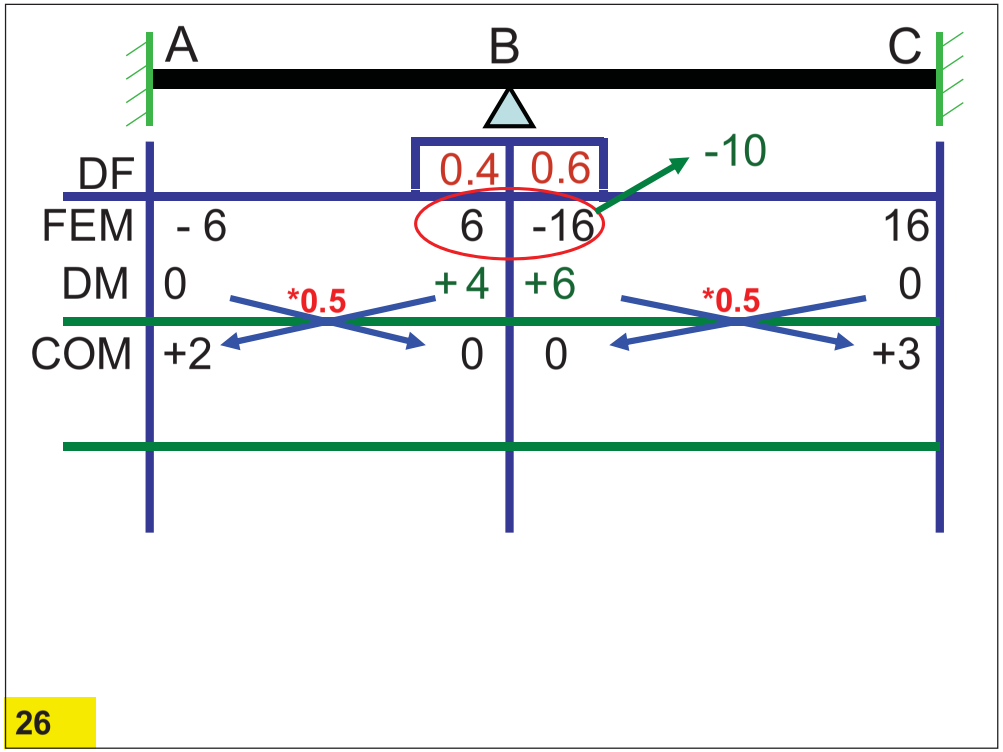
DF_{AB}	:	DF_{BC}
$\frac{2}{2+3}$	:	$\frac{2}{2+3}$
0.4	:	0.6

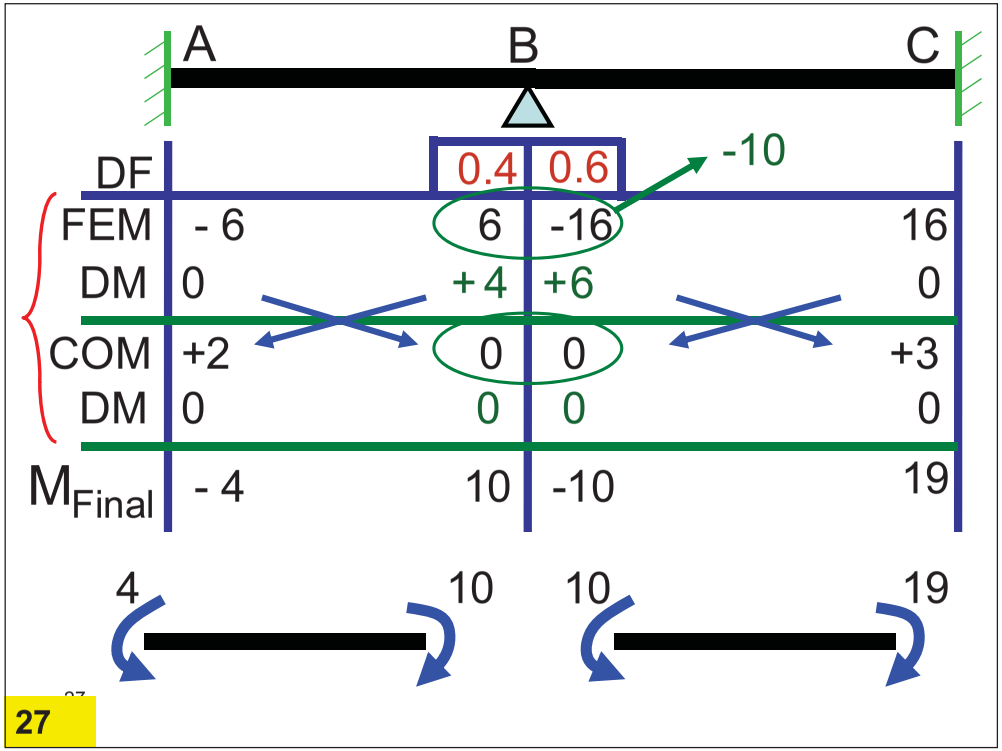
23

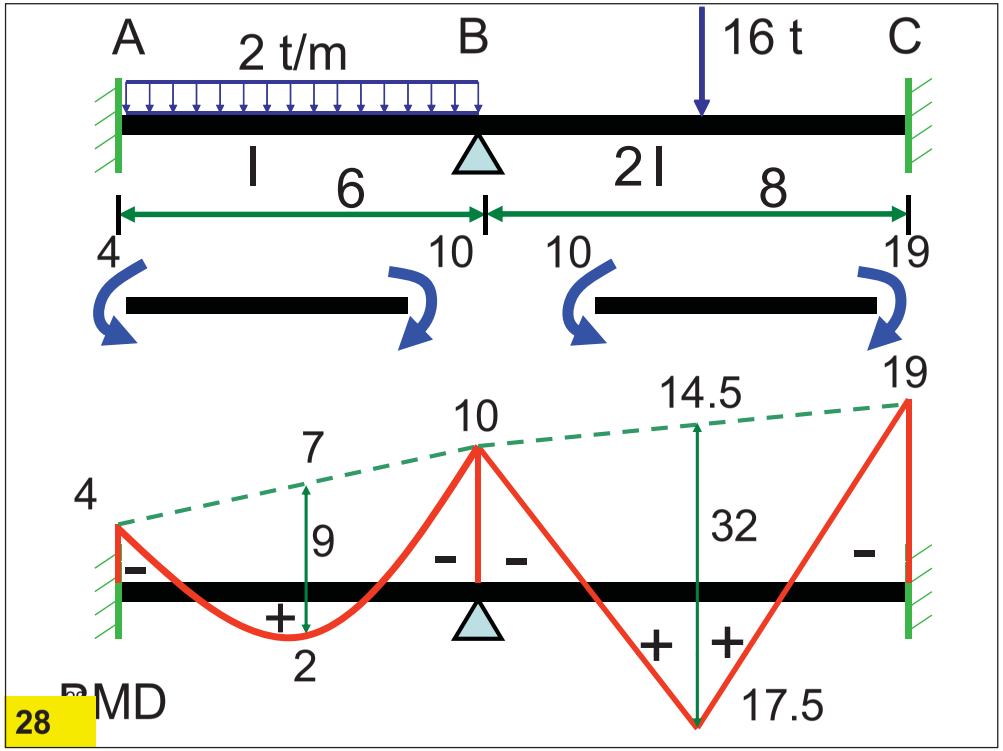


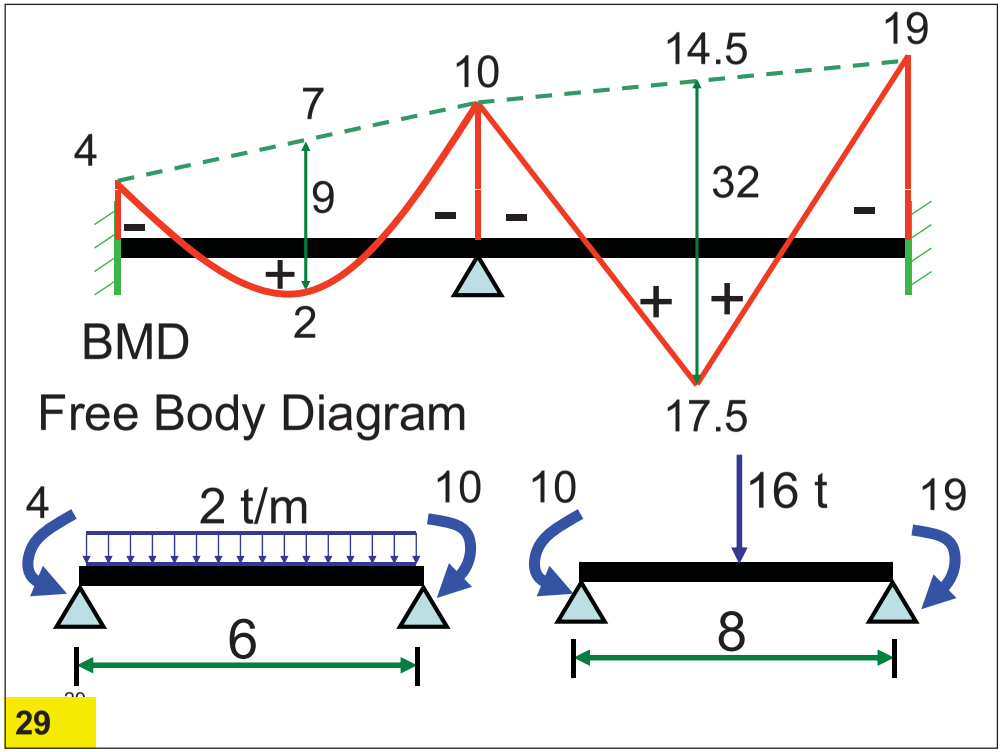
24


A
B
C
DF
0.4
0.6
-10
FEM
- 6
6
-16
16
DM
0
+4
+6
0
= +10*0.4=4.0
= +10*0.6=6.0
البداية و النهايه = صفر
25

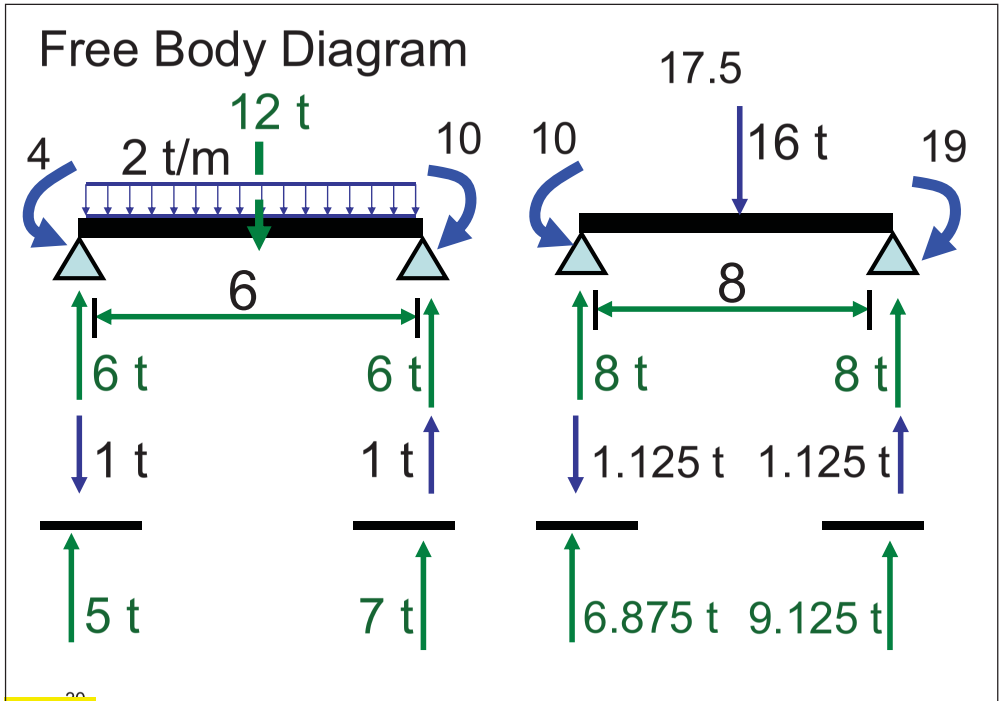

A
B
C
DF
0.4
0.6
-10
FEM
- 6
6
-16
16
DM
0
*0.5
+4
+6
*0.5
0
COM
+2
0
0
+3
26


A
B
C
DF
0.4
0.6
-10
FEM
- 6
6
-16
16
DM
0
+4
+6
0
COM
+2
0
0
+3
DM
0
0
0
0
M Final
- 4
10
-10
19
4
10
10
19
27

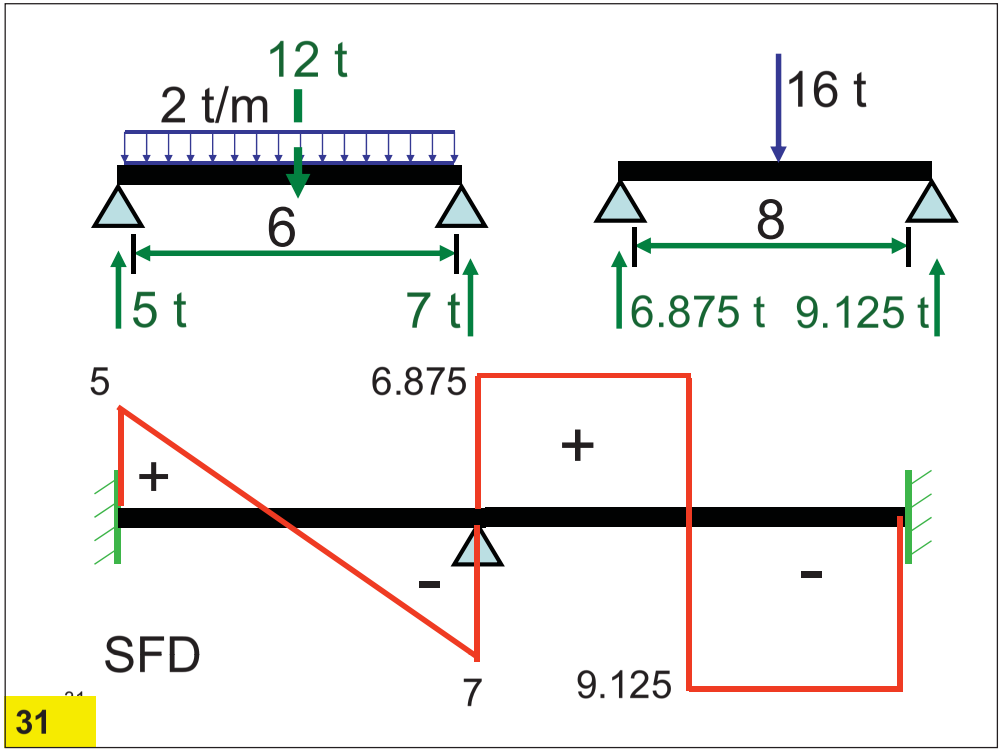

A
2 t/m
B
16 t
C
I
6
2 I
8
4
10
10
19
19
14.5
10
7
4
9
32
2
17.5
BMD
28



29



30



31

بســـم اللـــــه الرحمـــن الرحيـــم

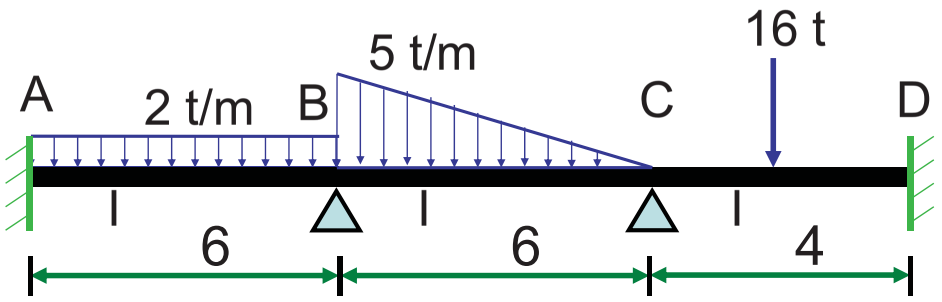
Moment Distribution

Continue Beams

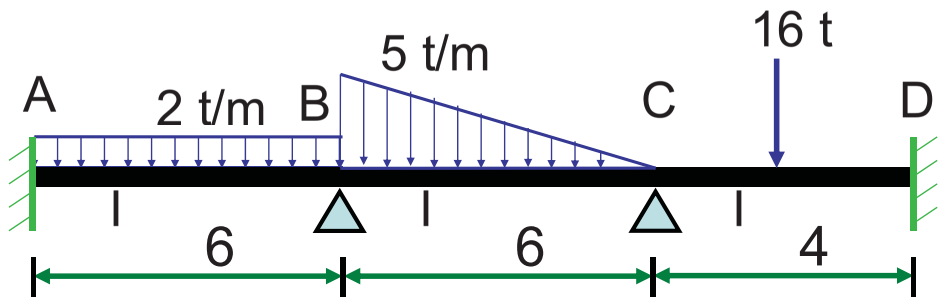
32

Example 2 :

Draw B.M.D for the shown beam



33

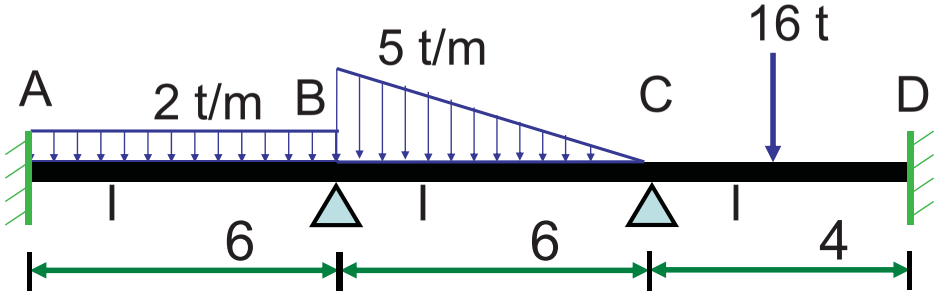


FEM :

$$M_{FAB} = \frac{wL^2}{12} = \frac{2\times 6^2}{12} = -6 \text{ tm}$$

$$M_{FBA} = 6 \text{ tm}$$

34

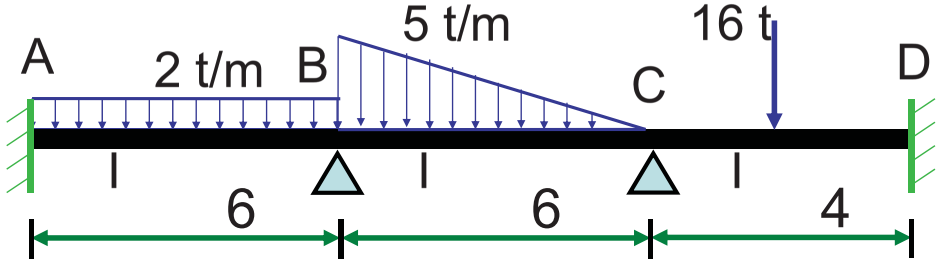


$$M_{FBC} = \frac{wL^2}{20} = \frac{5\times 6^2}{20} = -9 \text{ tm}$$

$$M_{FCB} = \frac{wL^2}{30} = \frac{5\times 6^2}{30} = 6 \text{ tm}$$

$$M_{FCD} = \frac{PL}{8} = \frac{16\times 4}{8} = -8 \text{ tm} \qquad M_{FDC} = 8 \text{ tm}$$

35



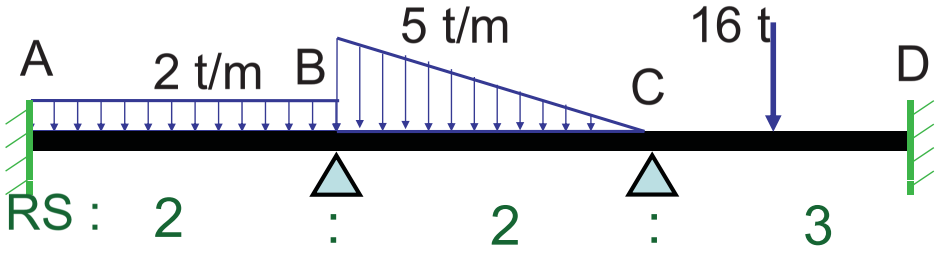
RS :

$$K_{AB} : K_{BC} : K_{CD}$$

$$\frac{1}{6} : \frac{1}{6} : \frac{1}{4}$$

$$2 : 2 : 3$$

36



RS : 2 : 2 : 3

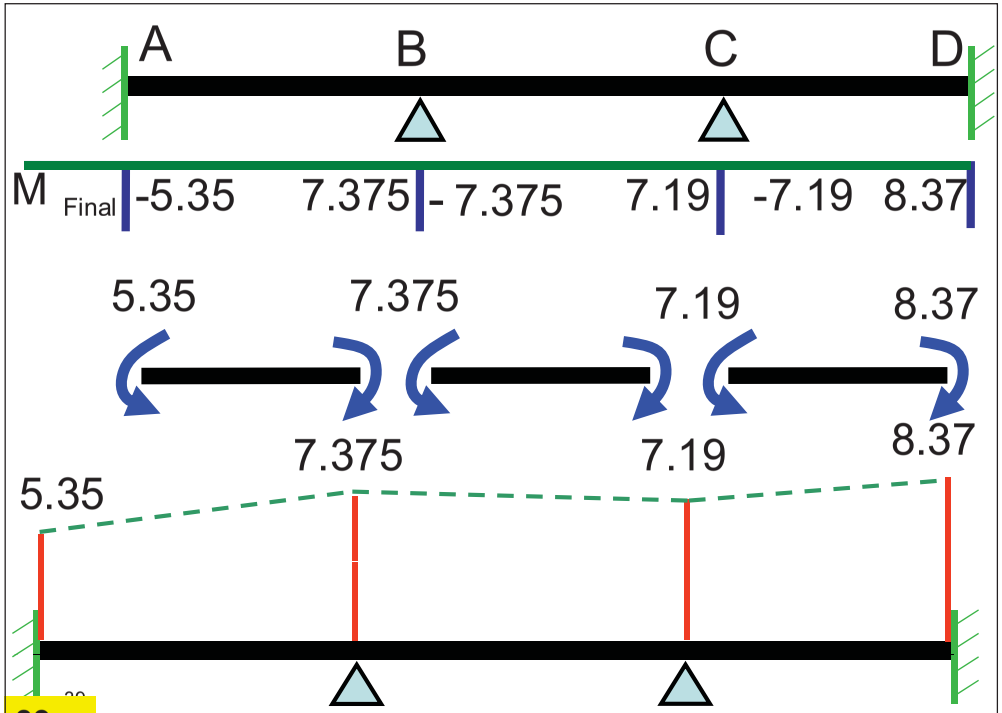
DF :

DF_{AB} :	DF_{BC}	DF_{BC} :	DF_{CD}
$\frac{2}{2+2}$:	$\frac{2}{2+2}$	$\frac{2}{2+3}$:	$\frac{3}{2+3}$
0.5 :	0.5	0.4 :	0.6

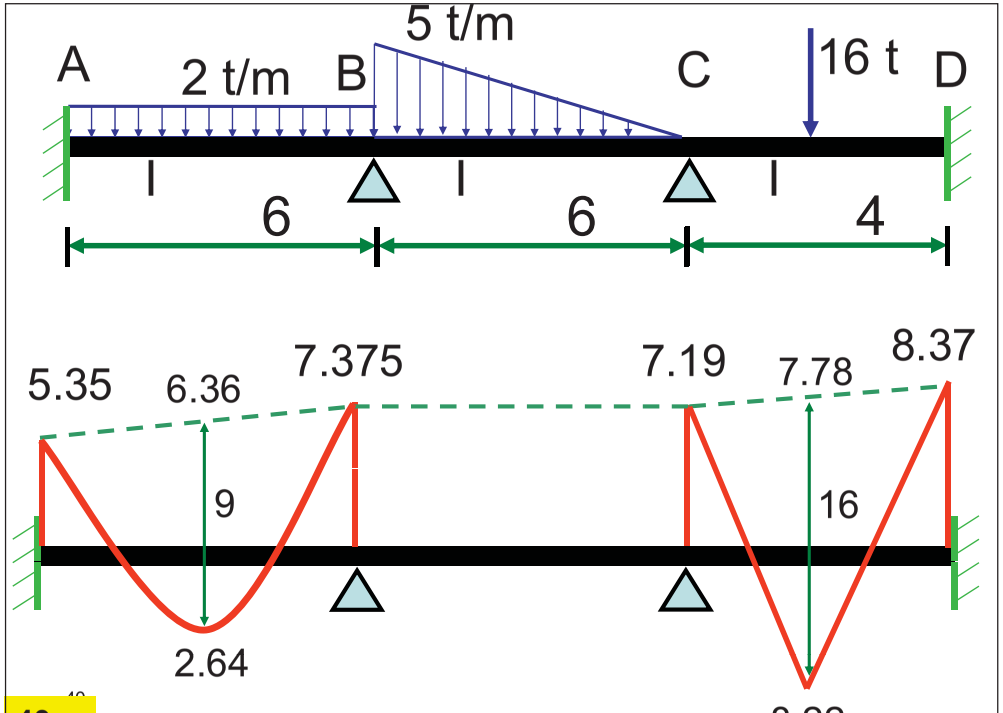
37

	A		B		C		D
DF		0.5	0.5	0.4	0.6		
FEM	-6	6	-9	-3	6	-8	-2	8
DM	0	+1.5	+1.5		+0.8	+1.2		0
COM	+0.75	0	+0.4		+0.75	0		+0.6
DM	0	-0.2	-0.2		-0.3	-0.45		0
COM	-0.1	0	-0.15		-0.10			-0.23
DM	0	+0.075	+0.075		+0.04	+0.06		0
M_{Final}	-5.35	7.375	-7.375		7.19	-7.19		8.37

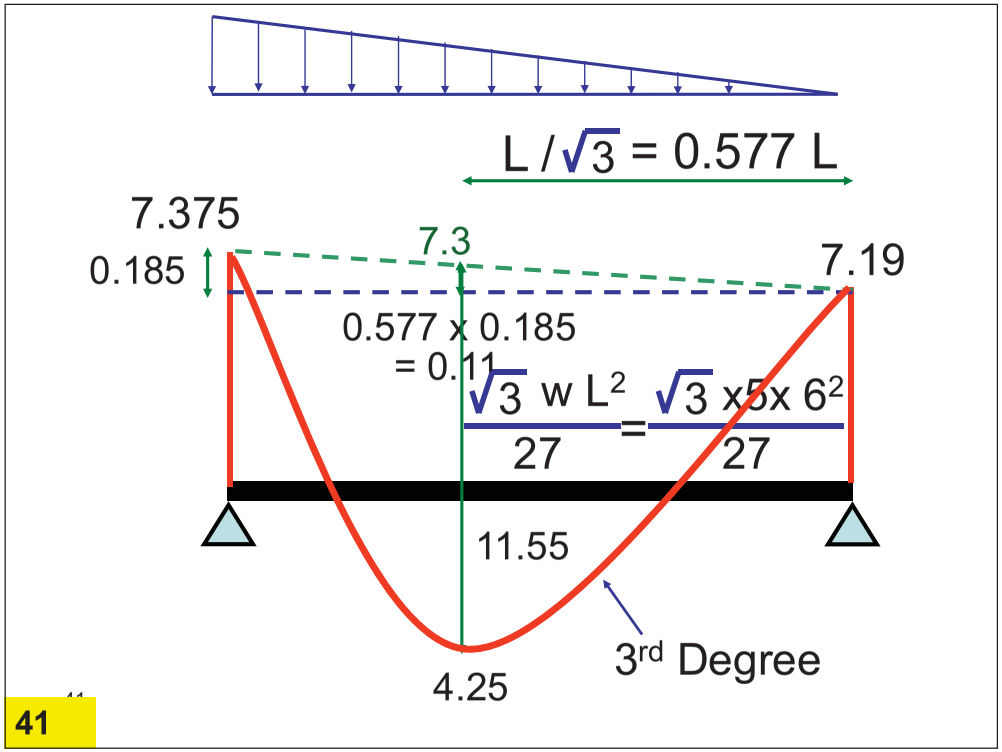
38



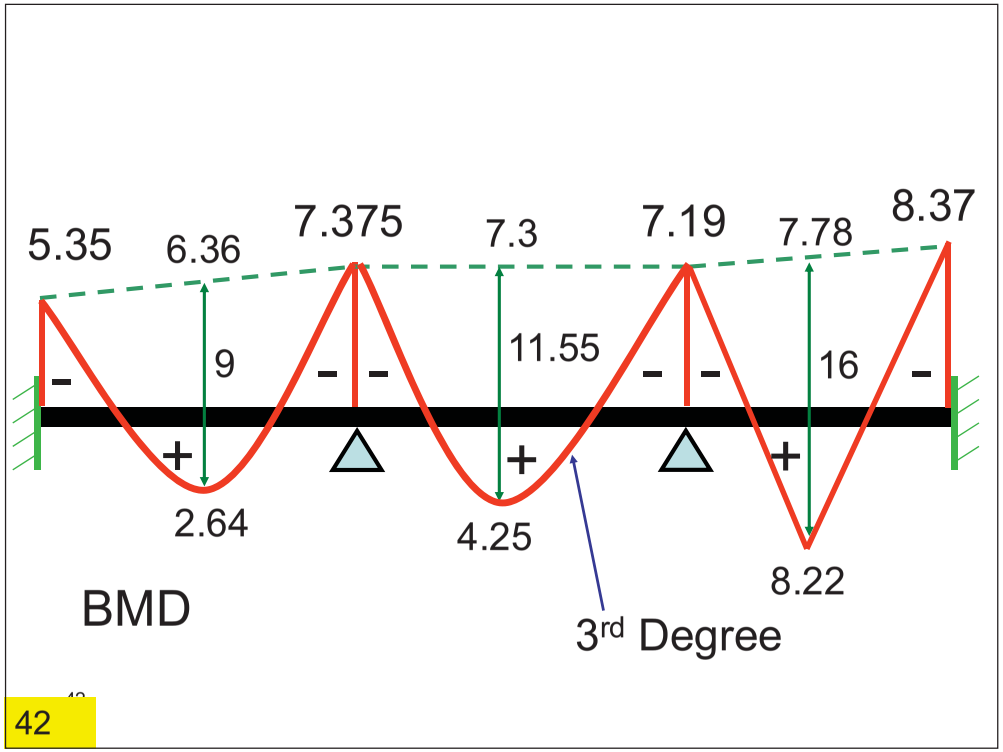
39



40



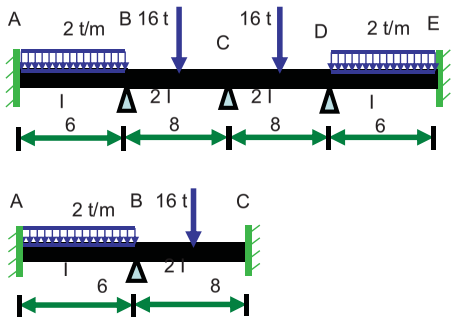
41



42

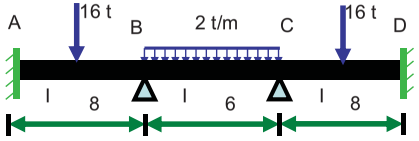
الحالات الخاصه

تماثل على support



يتم حل نصف المسألة كما فى المثال الاول

تماثل فى وسط باكيه



1. Fixed End Moment
2. Relative Stiffness

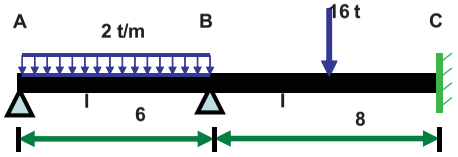
يتم ضرب الـ R.S * 0.5

R.S I/L : ½ I/L

3. Distribution Factor
4. Table :

43

حالة وجود hinge طرفى



1. Fixed End Moment

-6	6	-16	16
6	3		
0	9	-16	16

2. Relative Stiffness

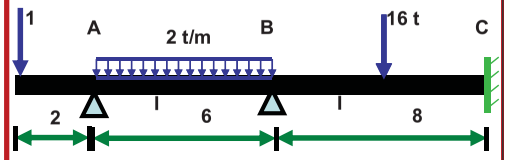
يتم ضرب الـ R.S * 3/4

R.S I/L : ¾ I/L

3. Distribution Factor

4. Table :

حالة وجود cantilever طرفى



1. Fixed End Moment

2	-6	6	-16	16
	4	2		
	-2	8	-16	16

2. Relative Stiffness

يتم ضرب الـ R.S * 3/4

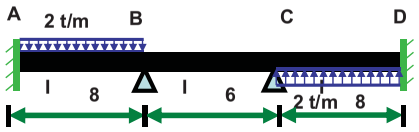
R.S I/L : ¾ I/L

3. Distribution Factor

4. Table :

44

تماثل عكسى فى وسط باكيه



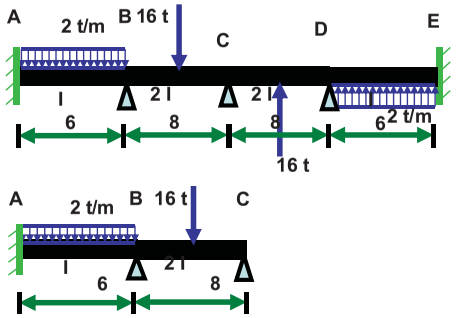
1. Fixed End Moment
2. Relative Stiffness

يتم ضرب الـ R.S * 3/2

R.S I/L : 3/2 I/L

3. Distribution Factor
4. Table :

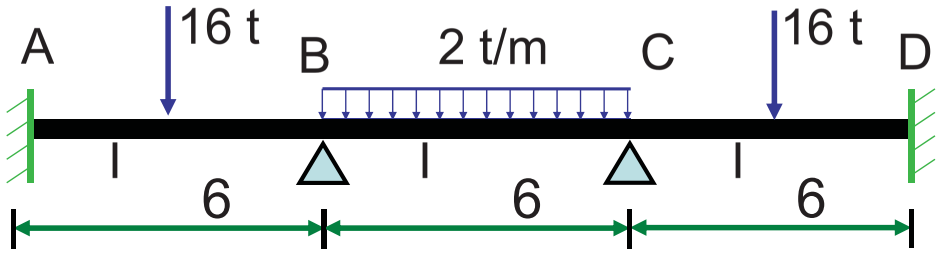
تماثل عكسى على support

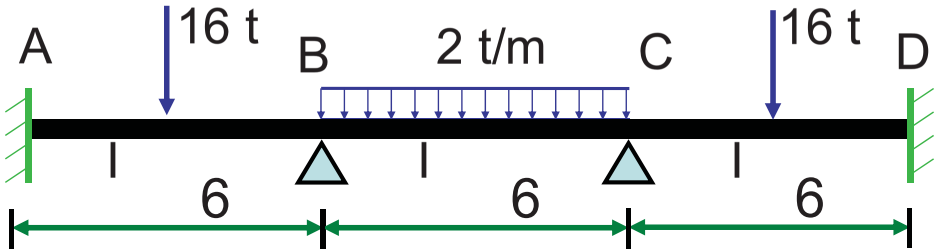


يتم حل نصف المسألة
كما فى حالة الـ hinge الطرفى

Example 3 :

Draw B.M.D for the shown beam





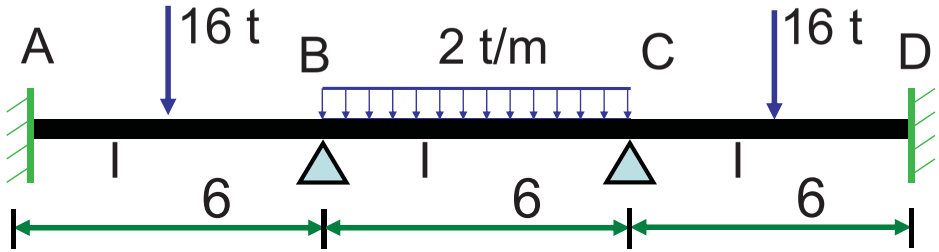
FEM :

$$M_{FAB} = \frac{PL}{8} = \frac{16\times6}{8} = -12 \text{ tm} \quad M_{FBA} = 12 \text{ tm}$$

$$M_{FBC} = \frac{wL^2}{12} = \frac{2\times6^2}{12} = -6 \text{ tm}$$

$$M_{FCB} = 6 \text{ tm}$$

$$M_{FCD} = \frac{PL}{8} = \frac{16\times6}{8} = -12 \text{ tm} \quad M_{FDC} = 12 \text{ tm}$$

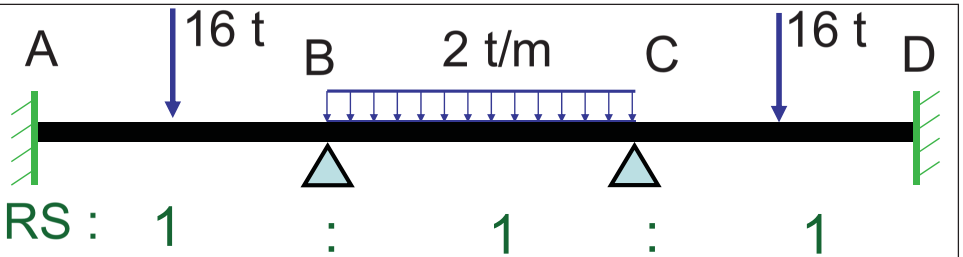


RS :

$$K_{AB} : K_{BC} : K_{CD}$$

$$\frac{1}{6} : \frac{1}{6} : \frac{1}{6}$$

$$1 : 1 : 1$$

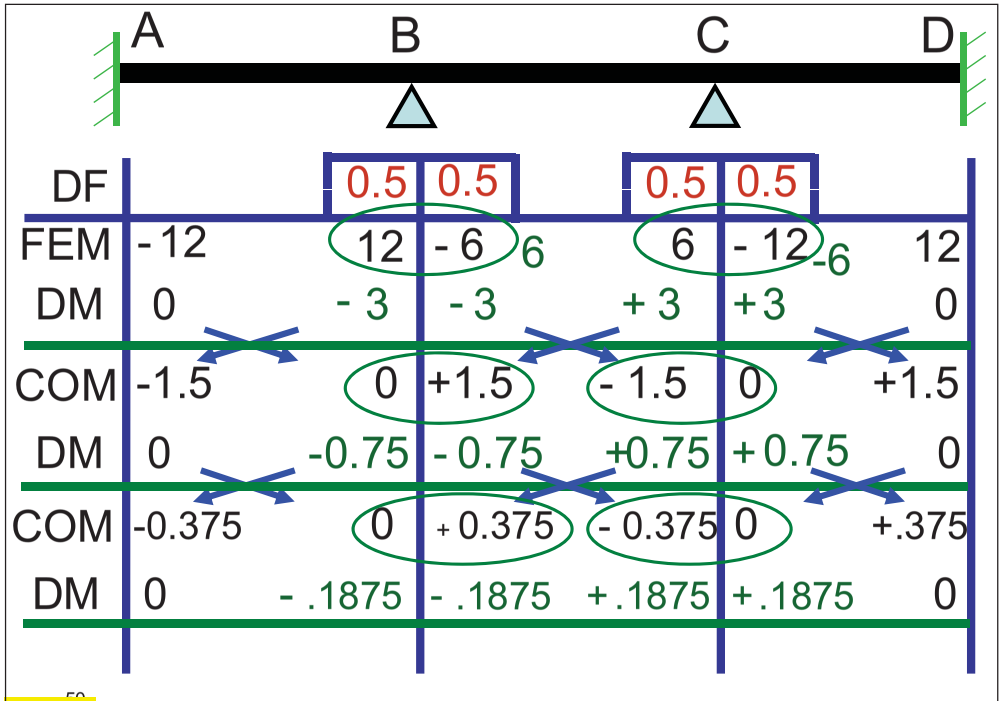


RS : 1 : 1 : 1

DF :

DF_{AB}	:	DF_{BC}	DF_{BC}	:	DF_{CD}
$\frac{1}{1+1}$	:	$\frac{1}{1+1}$	$\frac{1}{1+1}$	:	$\frac{1}{1+1}$
0.5	:	0.5	0.5	:	0.5

49



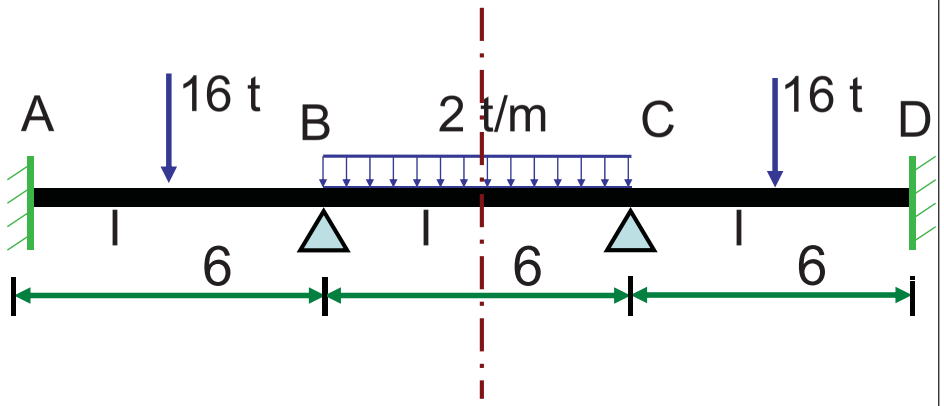
50

DF		0.5	0.5	0.5	0.5	
FEM	-12	12	-6	6	-12	12
DM	0	-3	-3	+3	+3	0
COM	-1.5	0	+1.5	-1.5	0	+1.5
DM	0	-0.75	-0.75	+0.75	+0.75	0
COM	-0.375	0	+0.375	-0.375	0	+.375
DM	0	-.1875	-.1875	+.1875	+.1875	0
COM	-.094	0	+.094	-.094	0	+.094
DM	0	-.047	-.047	+.047	+.047	0
M_{Final}	-13.969	8.0155	-8.0155	8.0155	-8.0155	13.969

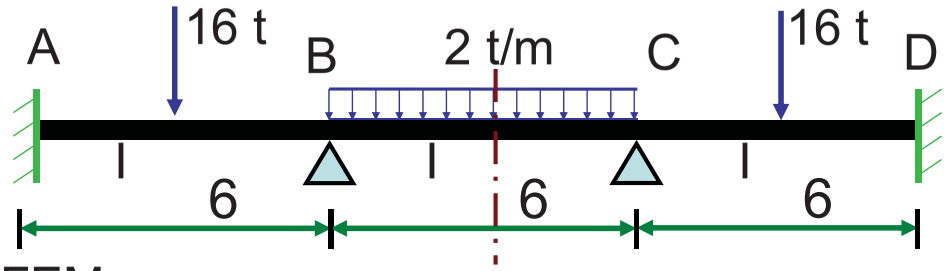
51

Example 4

Draw B.M.D for the shown beam



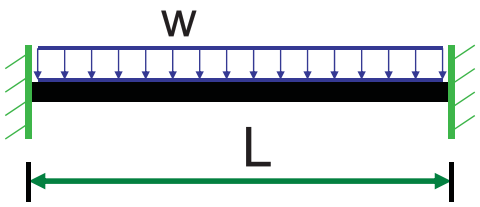
52



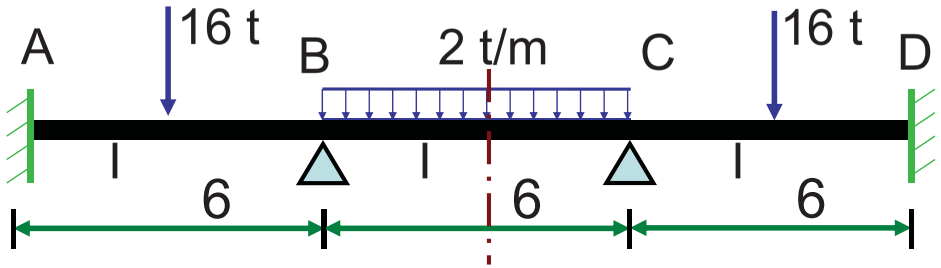
FEM :

$$M_{FAB} = \frac{PL}{8} = \frac{16 \times 6}{8} = -12 \text{ tm} \quad M_{FBA} = 12 \text{ tm}$$

$$M_{FBC} = \frac{wL^2}{12} = \frac{2 \times 6^2}{12} = -6 \text{ tm}$$



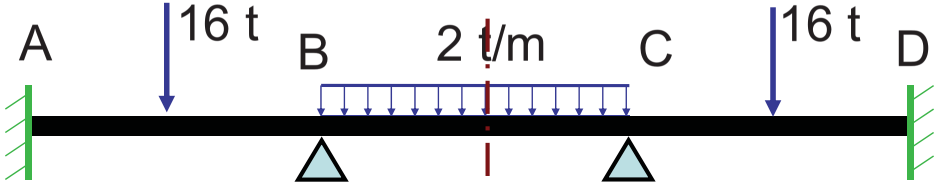
53



RS :

K_{AB}	:	K_{BC}
$\frac{1}{6}$	:	$\frac{1}{2} x \frac{1}{6}$
2	:	1

54

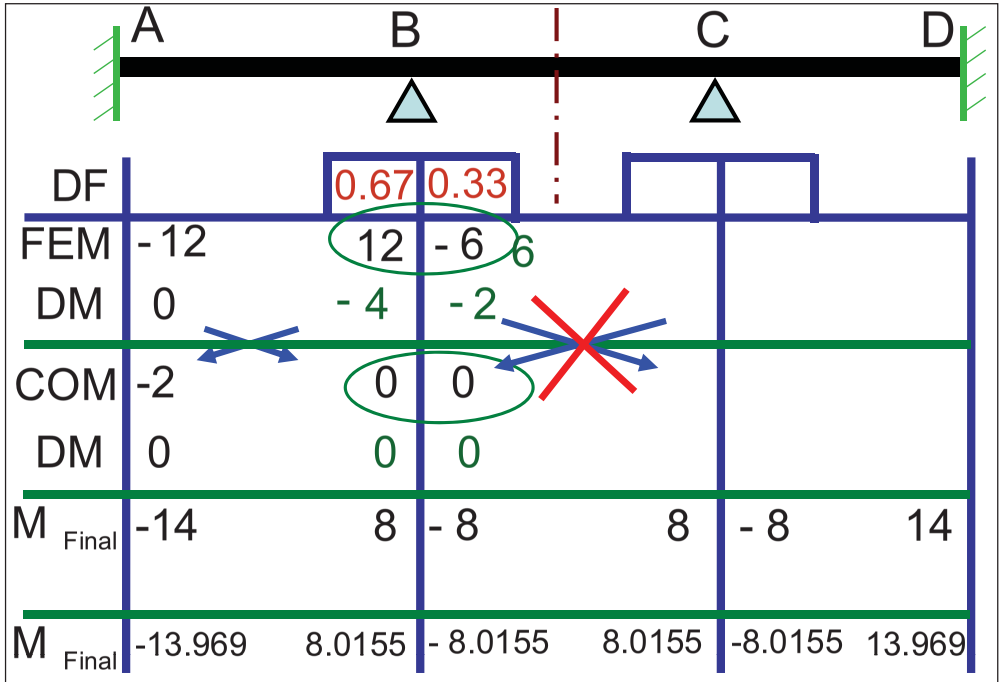


RS : 2 : 1

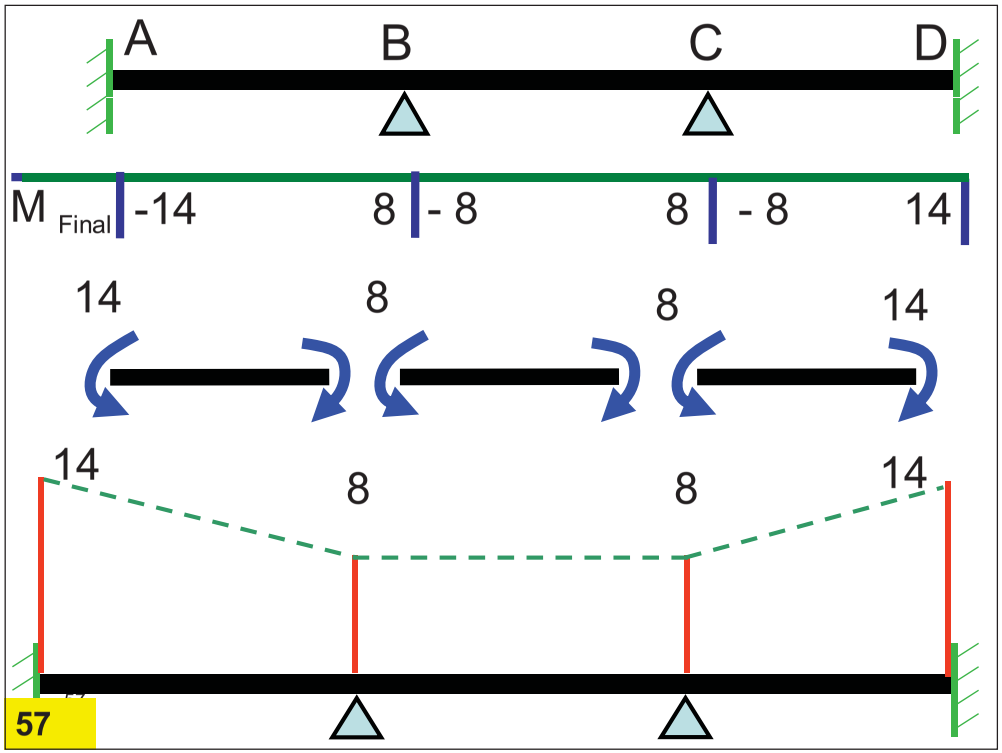
DF :

DF_{AB}	:	DF_{BC}
$\frac{2}{2+1}$	:	$\frac{1}{2+1}$
0.67	:	0.33

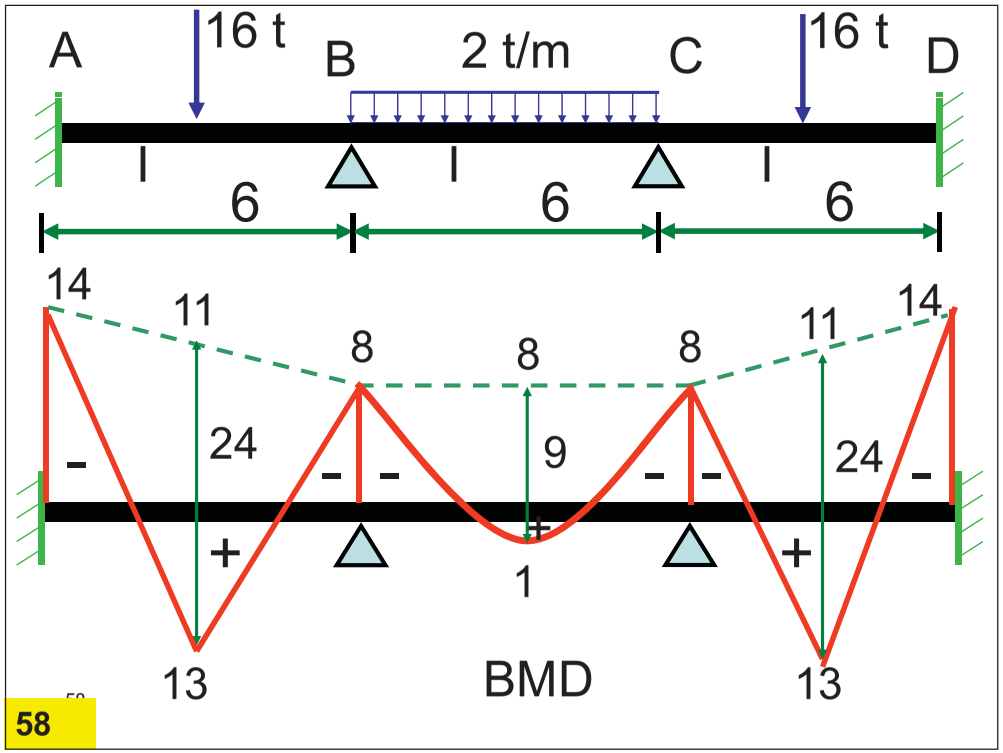
55



56



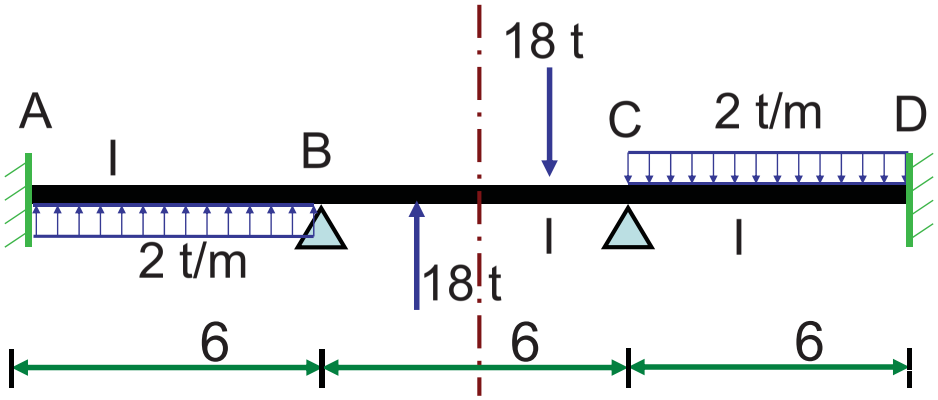
57



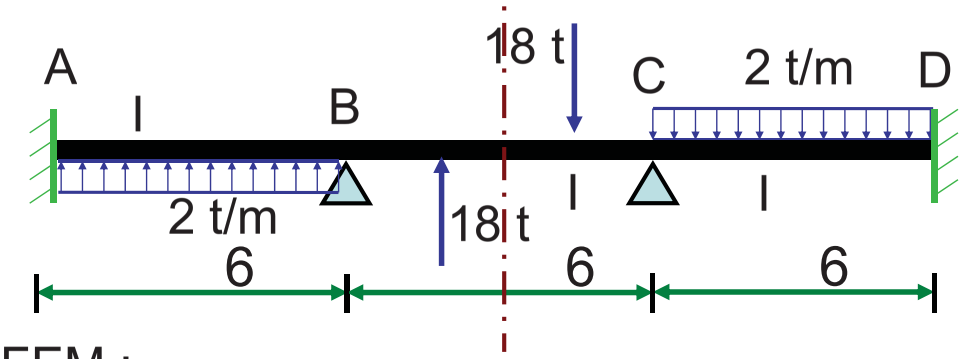
58

Example 5 :

Draw B.M.D for the shown beam



59

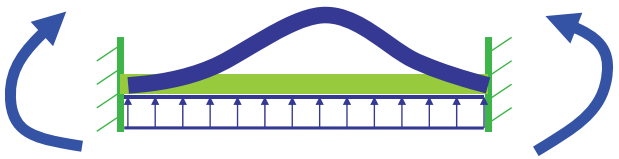


FEM :

$$M_{FAB} = \frac{wL^2}{12} = \frac{2 \times 6^2}{12} = +\ 6\ \text{tm}$$

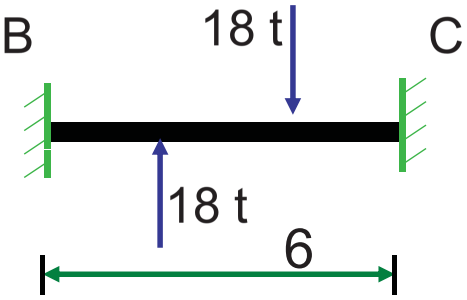
$$M_{FBA} = -\ 6\ \text{tm}$$

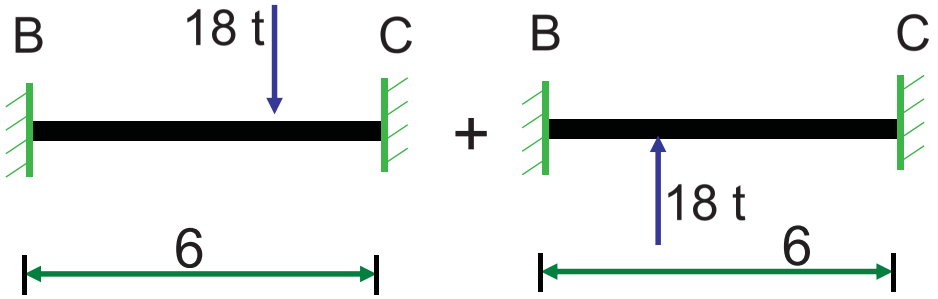
60



61

FEM :

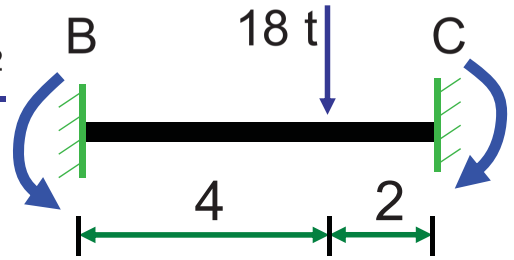




62

$\frac{18 \times 4 \times 2^2}{6^2} = -8$

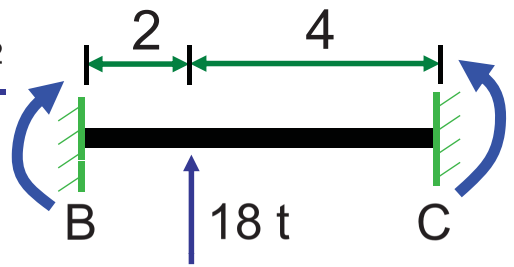
$\frac{18 \times 2 \times 4^2}{6^2} = +16$



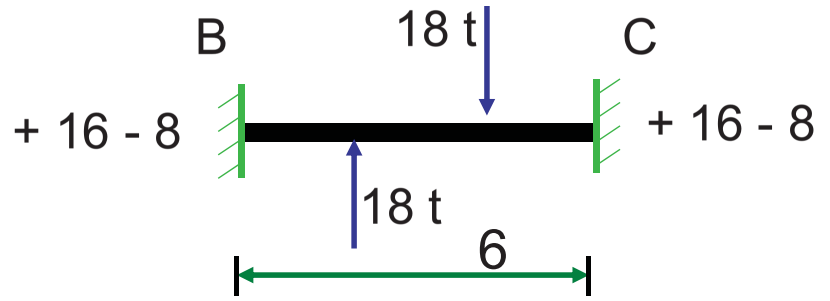
+

$\frac{18 \times 2 \times 4^2}{6^2} = +16$

$\frac{18 \times 4 \times 2^2}{6^2} = -8$



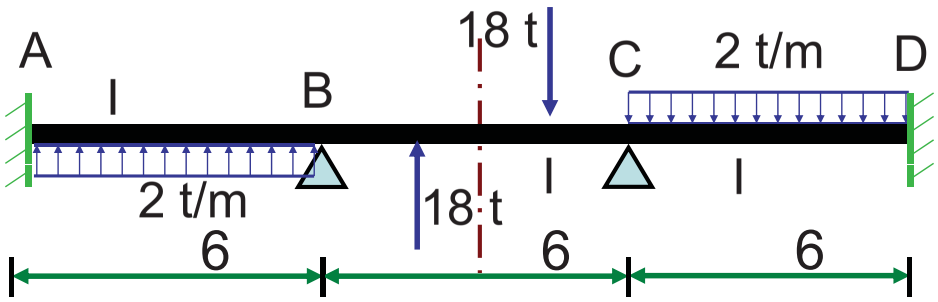
63



$M_{F_{BC}} = 8$ tm

$M_{F_{CB}} = 8$ tm

64



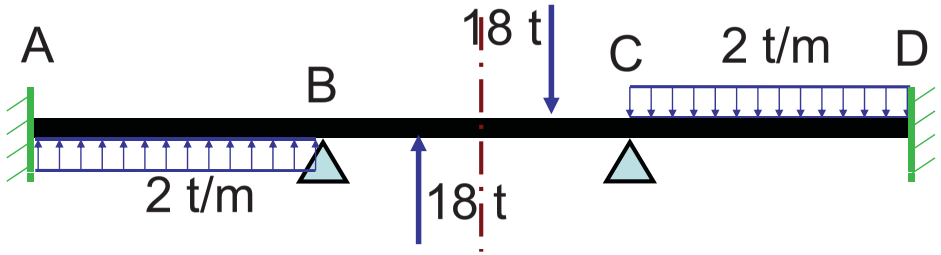
RS :

$$K_{AB} : K_{BC}$$

$$\frac{1}{6} : \frac{3}{2} x \frac{1}{6}$$

$$2 : 3$$

65



RS : 2 : 3

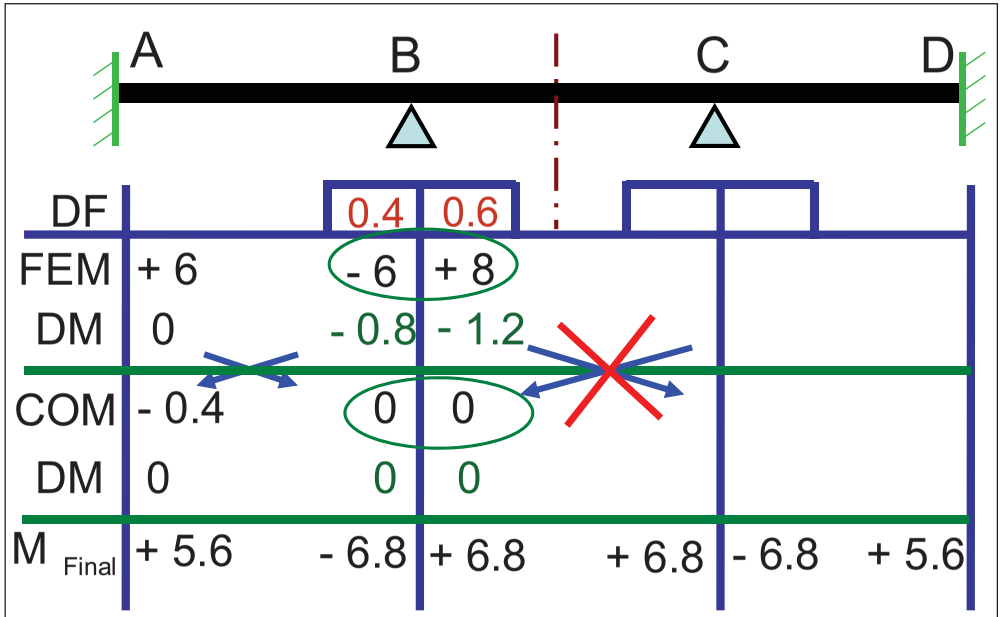
DF :

$$DF_{AB} : DF_{BC}$$

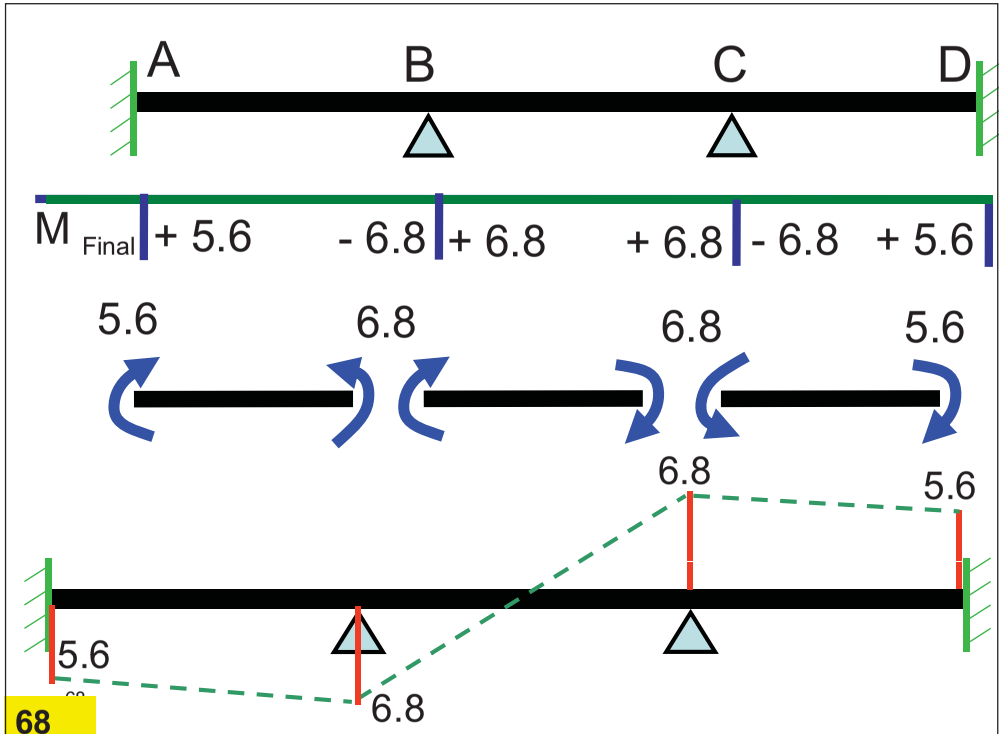
$$\frac{2}{2+3} : \frac{3}{2+3}$$

$$0.4 : 0.6$$

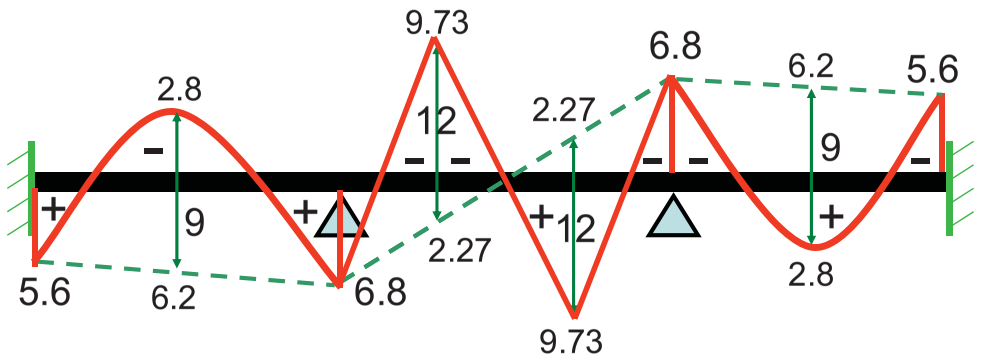
66



67



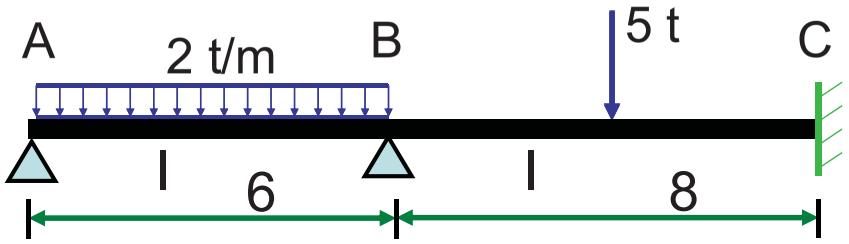
68

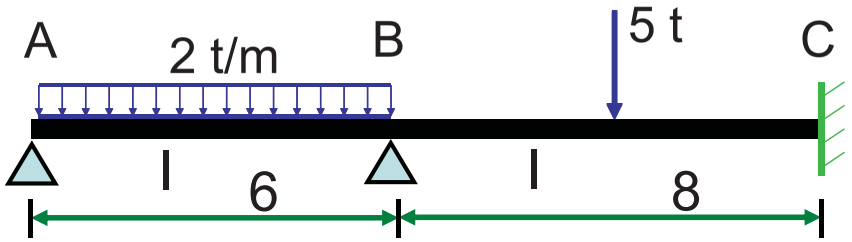


BMD

Example 6 :

Draw B.M.D for the shown beam



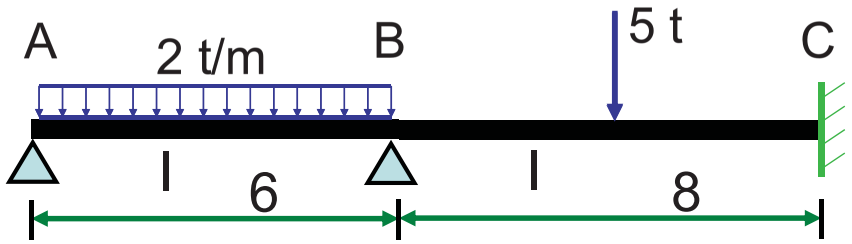


FEM :

Fixed End Moment

M_{FAB} M_{FBA} M_{FBC} M_{FCB}

$$M_{FAB} = M_{FBA} = \frac{wL^2}{12} \qquad M_{FBC} = M_{FCB} = \frac{PL}{8}$$

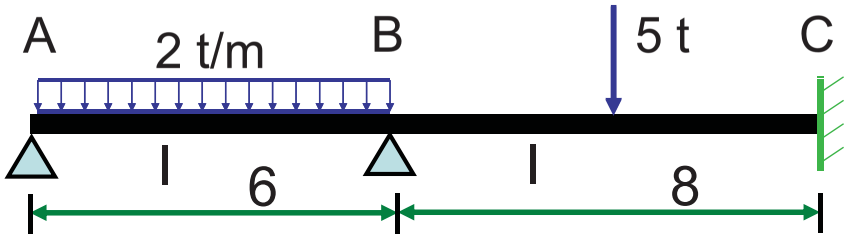


$$M_{FAB} = \frac{wL^2}{12} = \frac{2\times 6^2}{12} = -6 \text{ tm}$$

$$M_{FBA} = 6 \text{ tm}$$

$$M_{FBC} = \frac{PL}{8} = \frac{5\times 8}{8} = -5 \text{ tm}$$

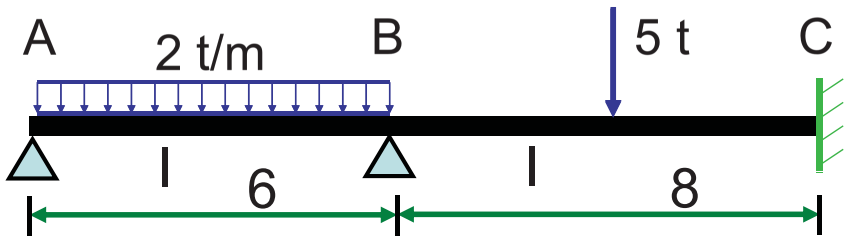
$$M_{FCB} = 5 \text{ tm}$$



RS : Relative Stiffness

K_{AB}	:	K_{BC}
$\frac{3}{4} \times \frac{1}{6}$	:	$\frac{1}{8}$
$\frac{1}{8}$	:	$\frac{1}{8}$
1	:	1

73

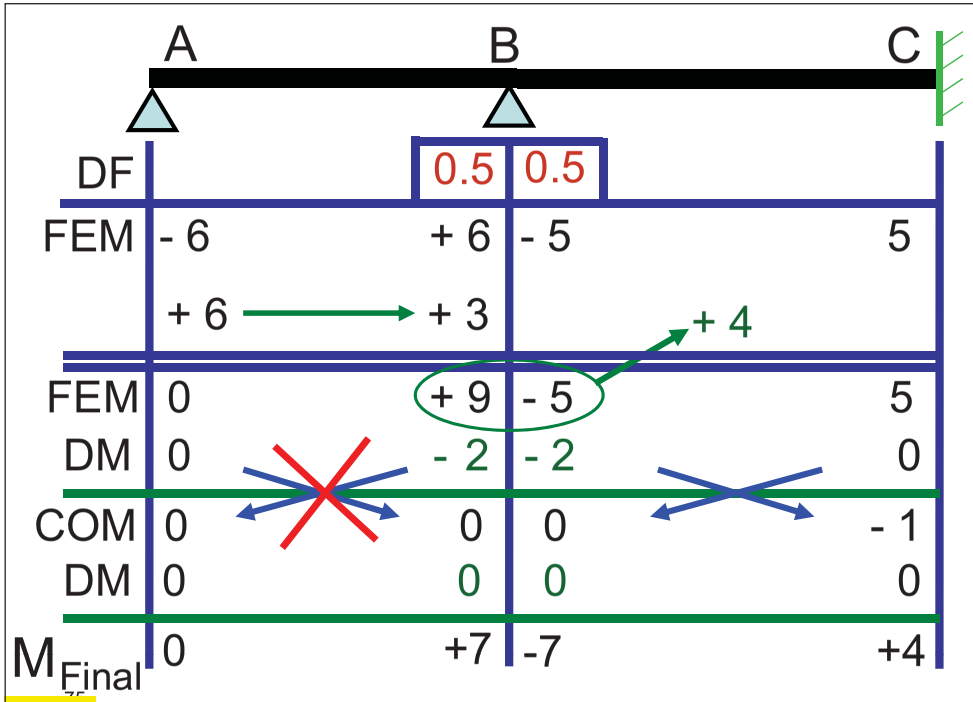


DF :

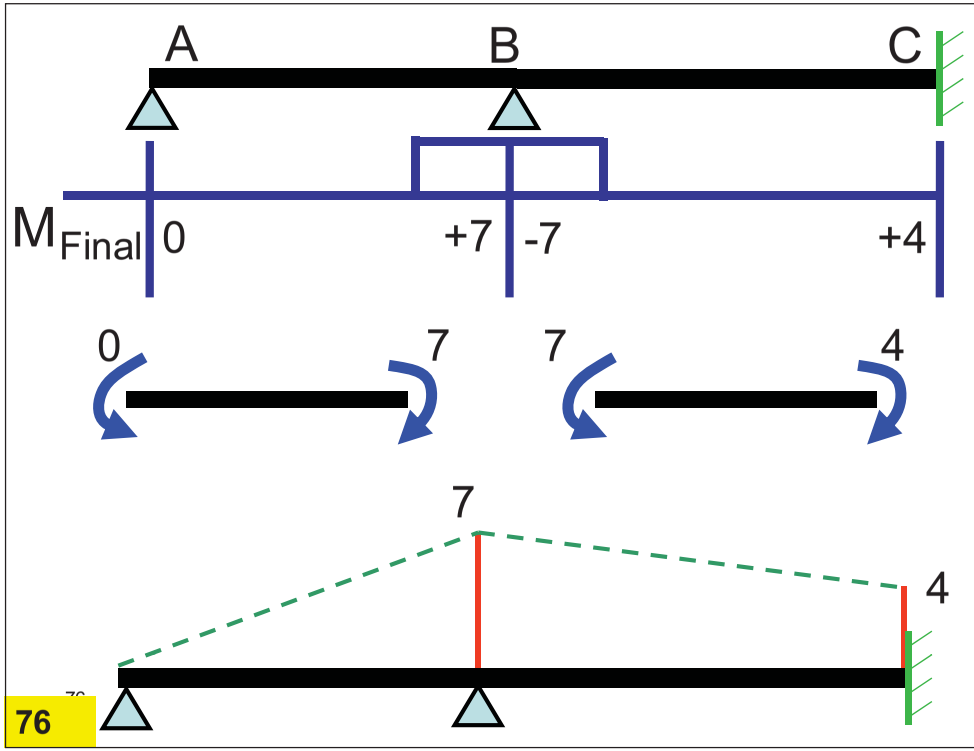
DF_{AB}	:	DF_{BC}
$\frac{1}{1+1}$	:	$\frac{1}{1+1}$
0.5	:	0.5

K_{AB}	:	K_{BC}
1	:	1

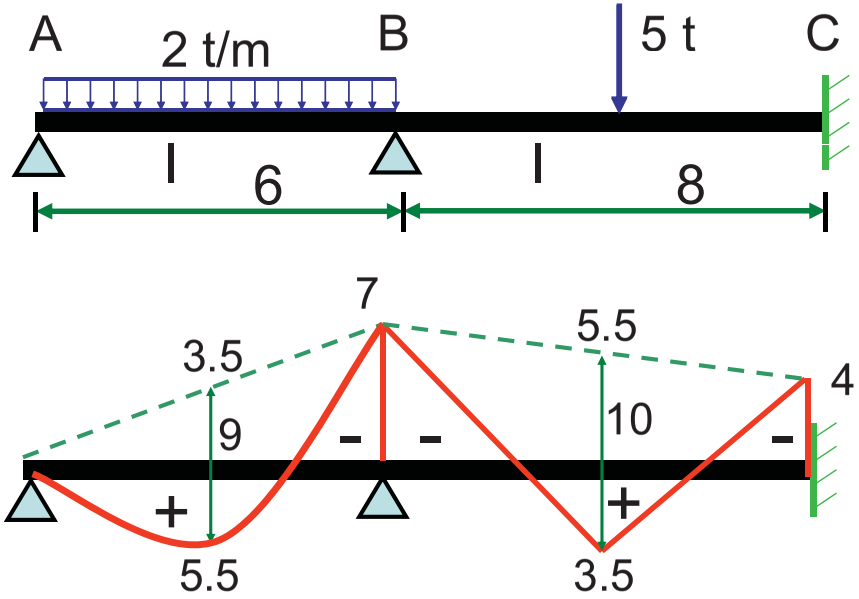
74



75



76

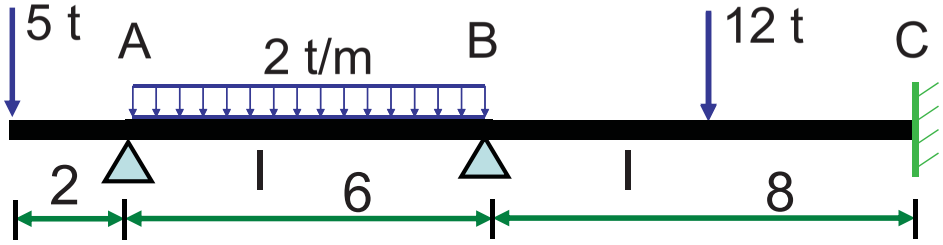


BMD

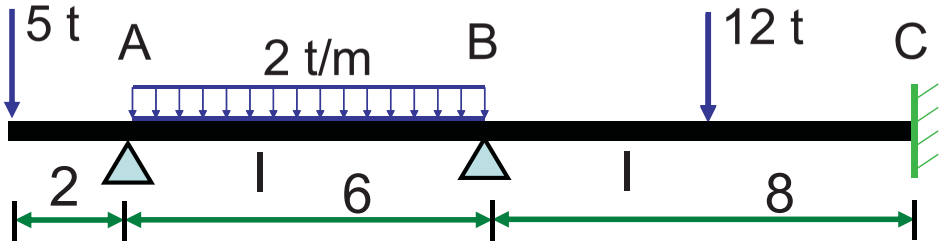
77

Example 7 :

Draw B.M.D for the shown beam

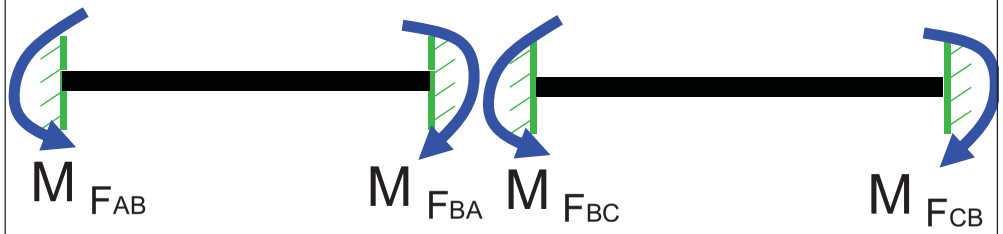


78



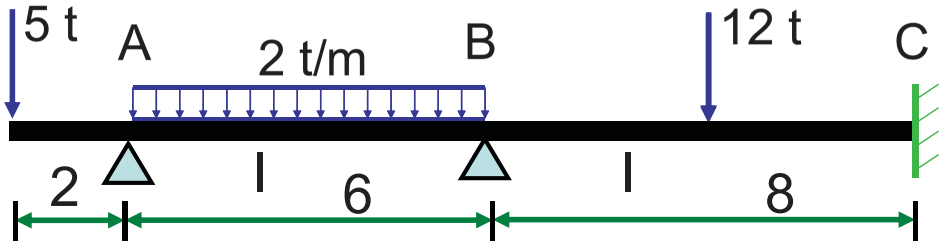
FEM :

Fixed End Moment



$$M_{FAB} = M_{FBA} = \frac{wL^2}{12} \qquad M_{FBC} = M_{FCB} = \frac{PL}{8}$$

79



FEM :

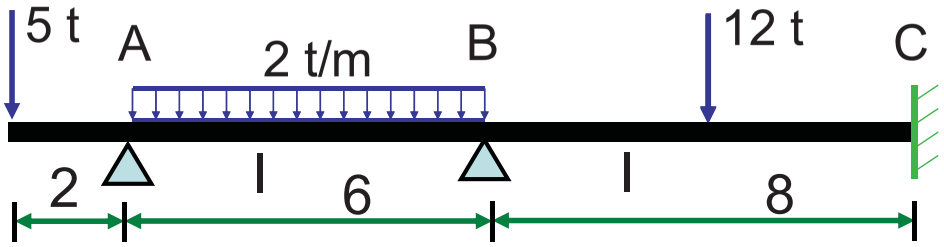
$$M_{FAB} = \frac{wL^2}{12} = \frac{2\times 6^2}{12} = -6 \text{ tm}$$

$$M_{FBA} = 6 \text{ tm}$$

$$M_{FBC} = \frac{PL}{8} = \frac{12\times 8}{8} = -12 \text{ tm}$$

$$M_{FCB} = 12 \text{ tm}$$

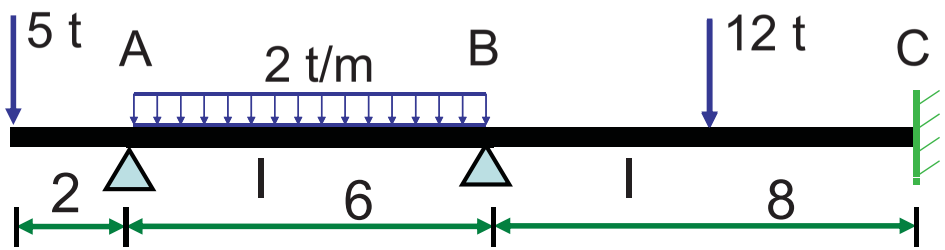
80



RS : Relative Stiffness

K_{AB}	:	K_{BC}
$\frac{3}{4} \times \frac{1}{6}$	:	$\frac{1}{8}$
$\frac{1}{8}$	:	$\frac{1}{8}$
1	:	1

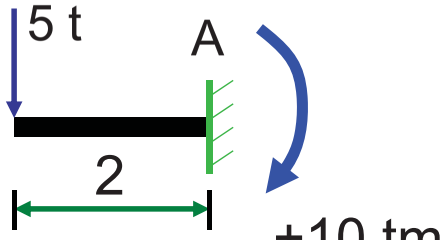
81



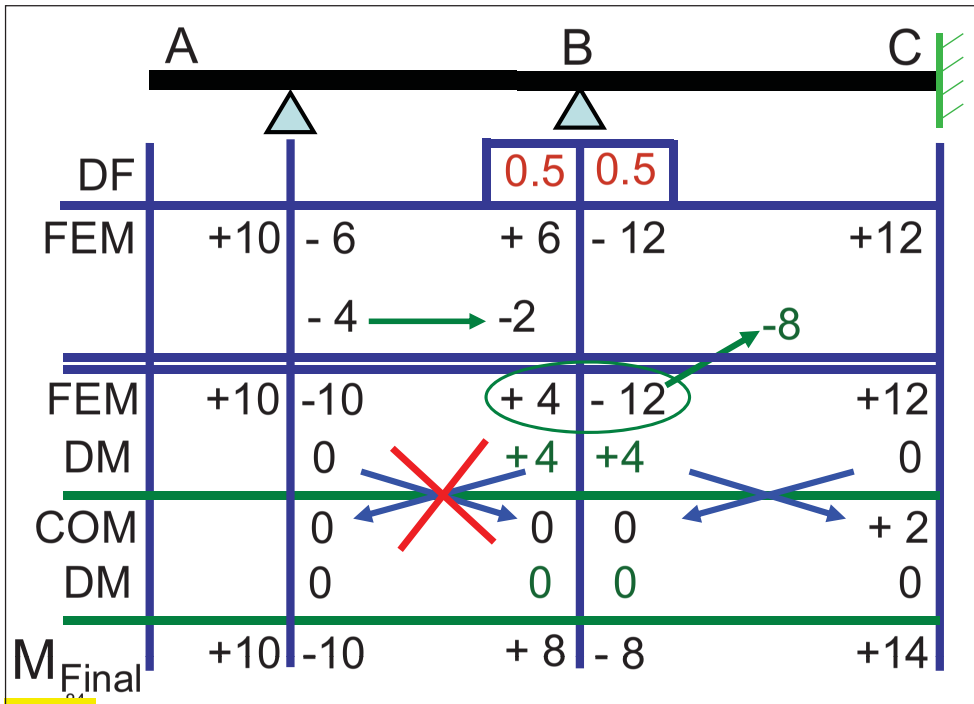
DF :

DF_{AB}	:	DF_{BC}	K_{AB}	:	K_{BC}
$\frac{1}{1+1}$	:	$\frac{1}{1+1}$	1	:	1
0.5	:	0.5			

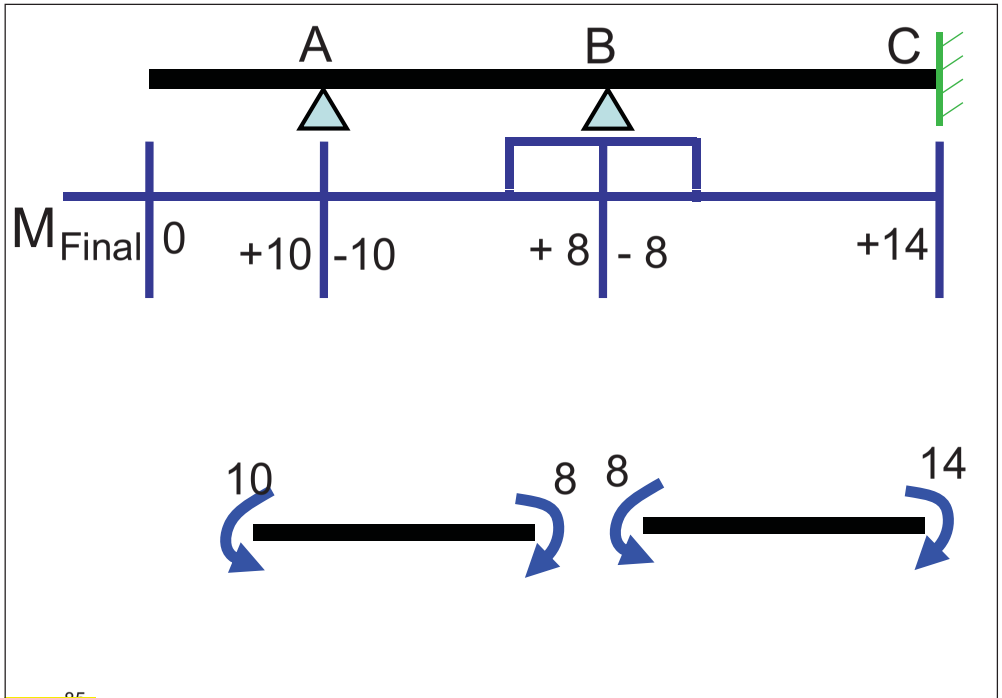
82



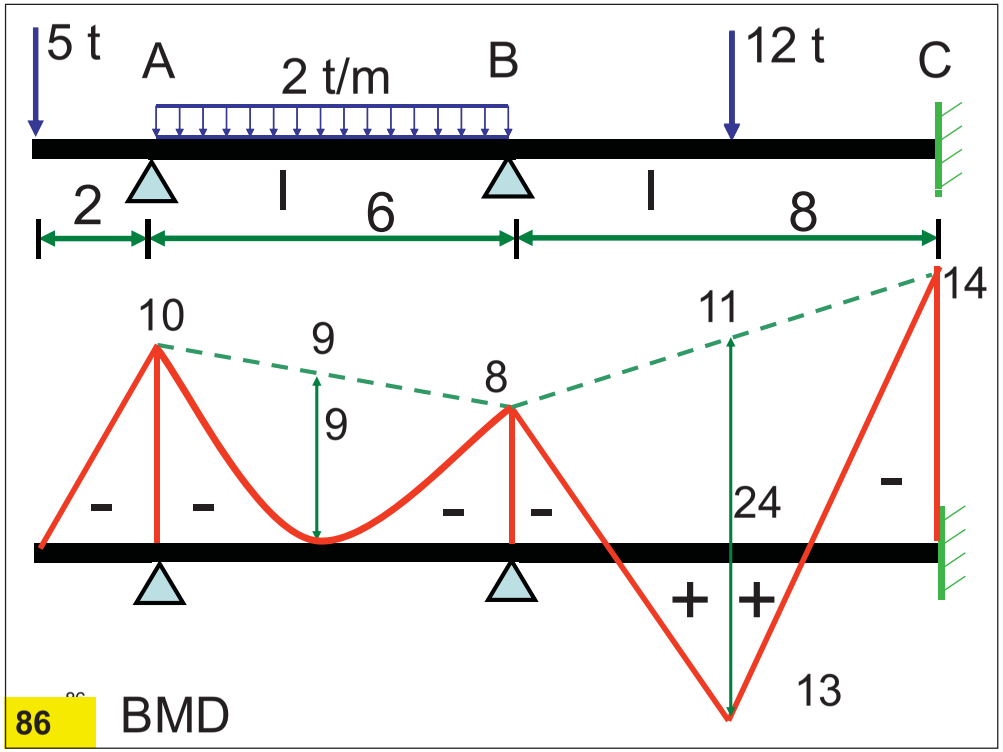
83



84



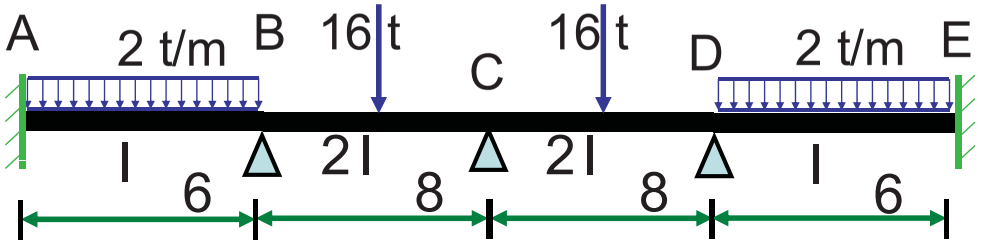
85



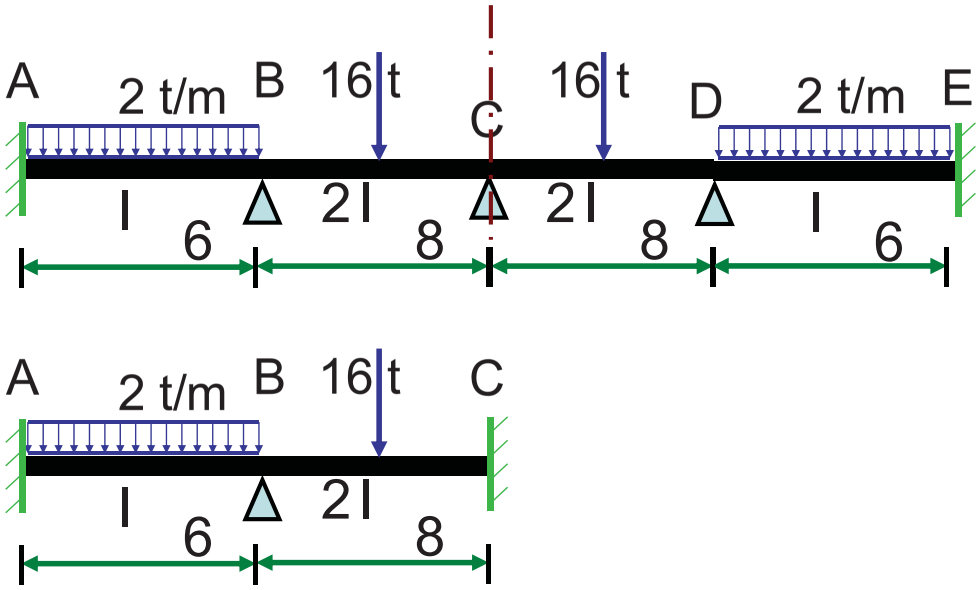
86 BMD

Example 8 :

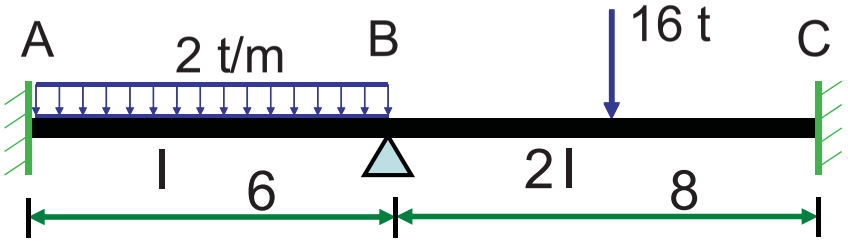
Draw B.M.D for the shown beam



87



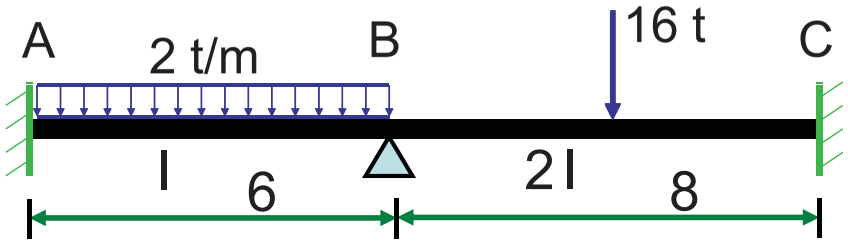
88



FEM : Fixed End Moment

$$M_{FAB} = M_{FBA} = \frac{wL^2}{12} \qquad M_{FBC} = M_{FCB} = \frac{PL}{8}$$

89



FEM :

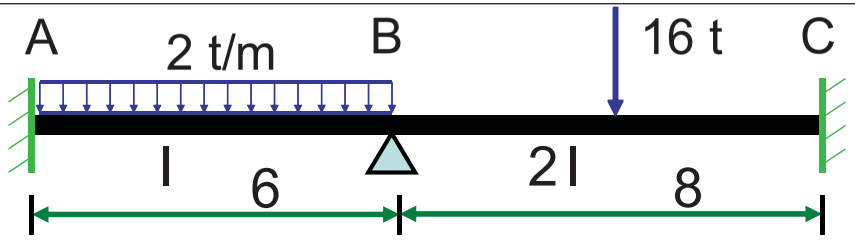
$$M_{FAB} = \frac{wL^2}{12} = \frac{2\times 6^2}{12} = -6 \text{ tm}$$

$$M_{FBA} = 6 \text{ tm}$$

$$M_{FBC} = \frac{PL}{8} = \frac{16\times 8}{8} = -16 \text{ tm}$$

$$M_{FCB} = 16 \text{ tm}$$

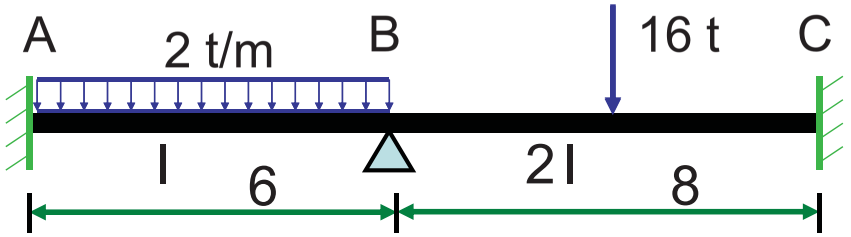
90



RS : Relative Stiffness

K_{AB}	:	K_{BC}
$\frac{1}{6}$	:	$\frac{2}{8}$
$\frac{1}{6}$	:	$\frac{1}{4}$
2	:	3

91

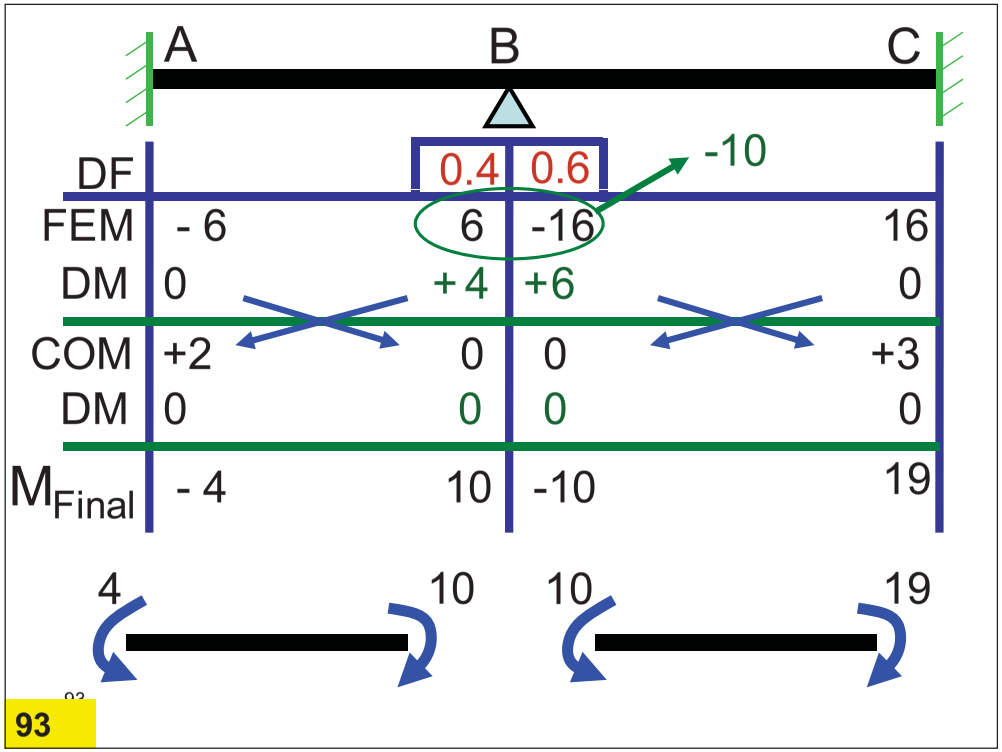


DF :

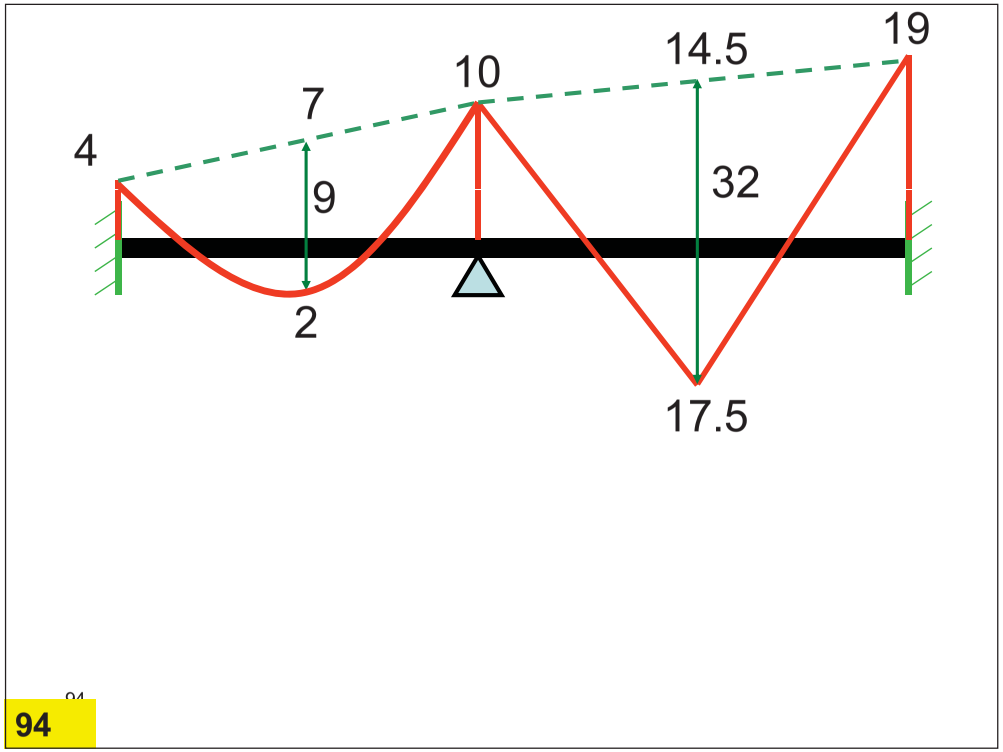
DF_{AB}	:	DF_{BC}
$\frac{2}{2+3}$	:	$\frac{3}{2+3}$
0.4	:	0.6

K_{AB}	:	K_{BC}
2	:	3

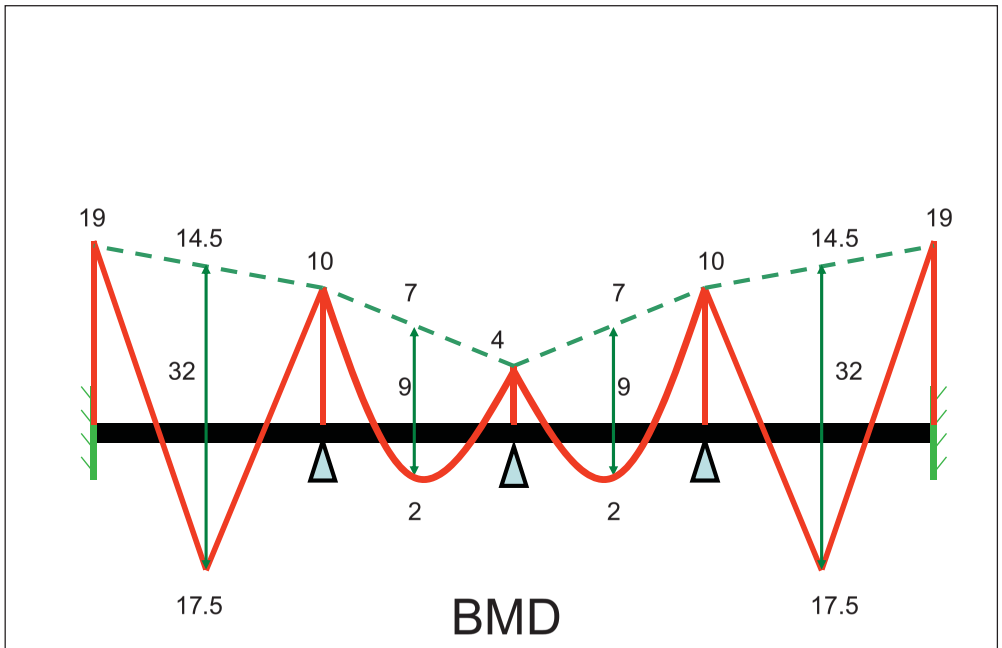
92



93



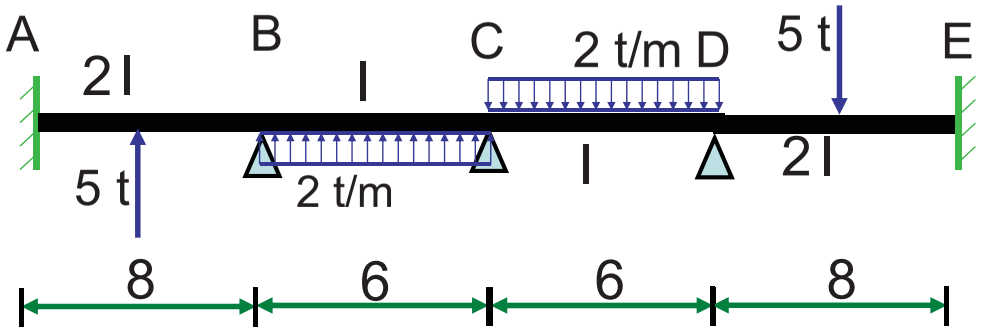
94



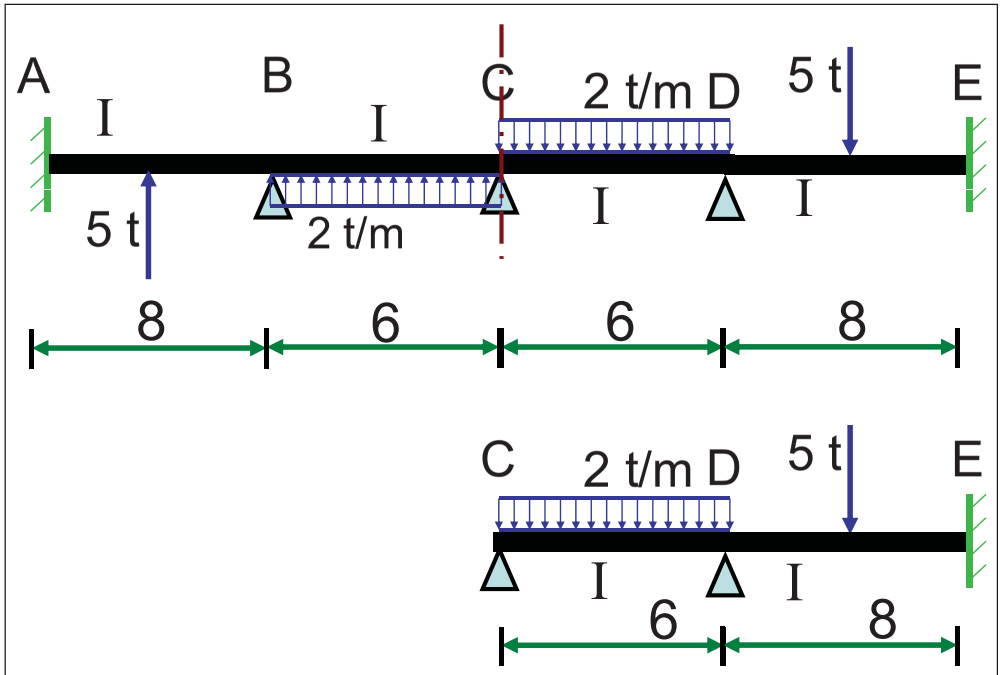
95

Example 9 :

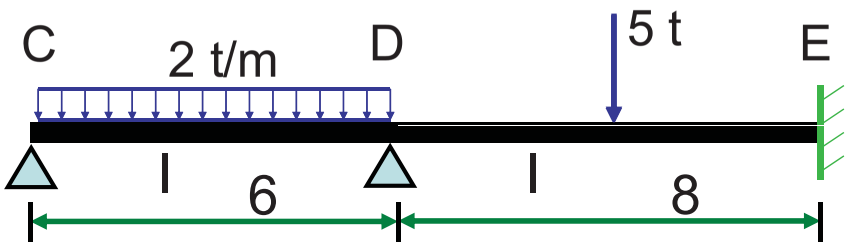
Draw B.M.D for the shown beam



96



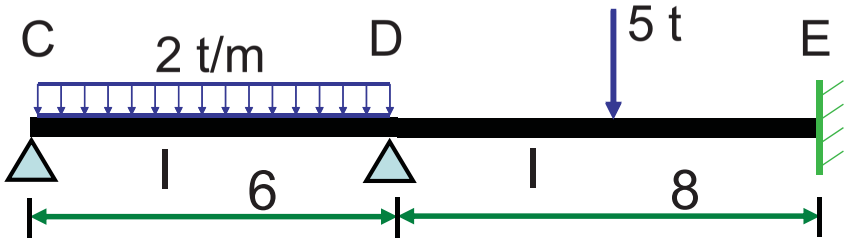
97



FEM : Fixed End Moment

$$M_{FCD} = M_{FDC} = \frac{wL^2}{12} \qquad M_{FDE} = M_{FED} = \frac{PL}{8}$$

98



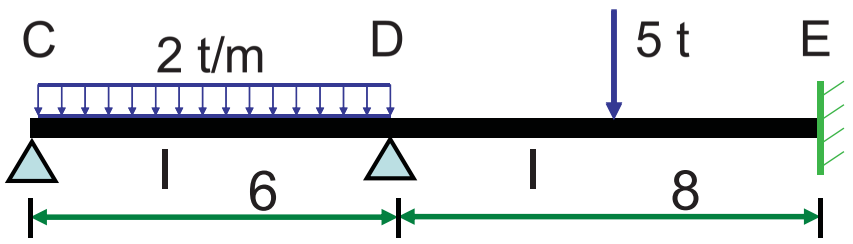
$$M_{FCD} = \frac{wL^2}{12} = \frac{2\times 6^2}{12} = -6 \text{ tm}$$

$$M_{FDC} = 6 \text{ tm}$$

$$M_{FDE} = \frac{PL}{8} = \frac{5\times 8}{8} = -5 \text{ tm}$$

$$M_{FED} = 5 \text{ tm}$$

99



RS : Relative Stiffness

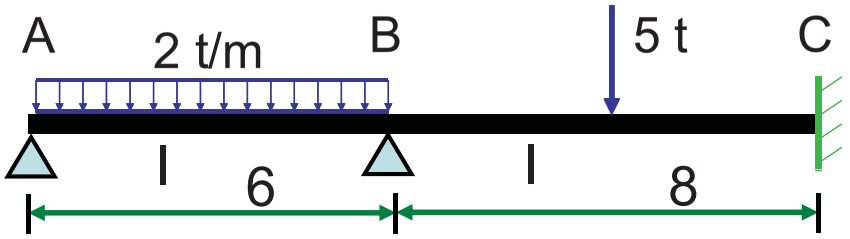
$$K_{CD} : K_{DE}$$

$$\frac{3}{4} \times \frac{1}{6} : \frac{1}{8}$$

$$\frac{1}{8} : \frac{1}{8}$$

$$1 : 1$$

100



DF :

$$DF_{CD} : DF_{DE}$$

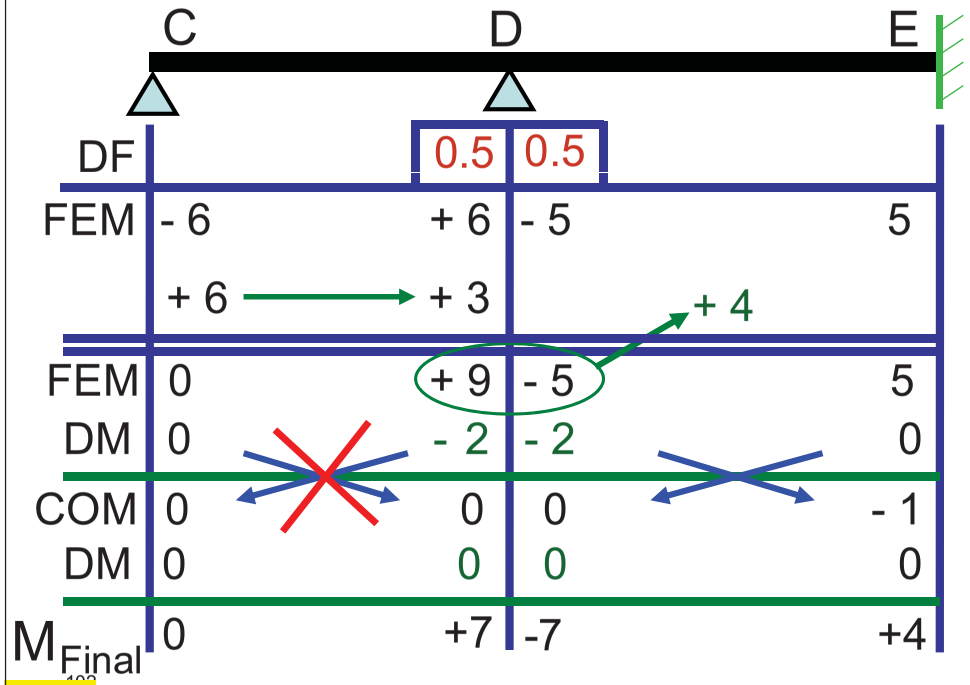
$$\frac{1}{1+1} : \frac{1}{1+1}$$

$$0.5 : 0.5$$

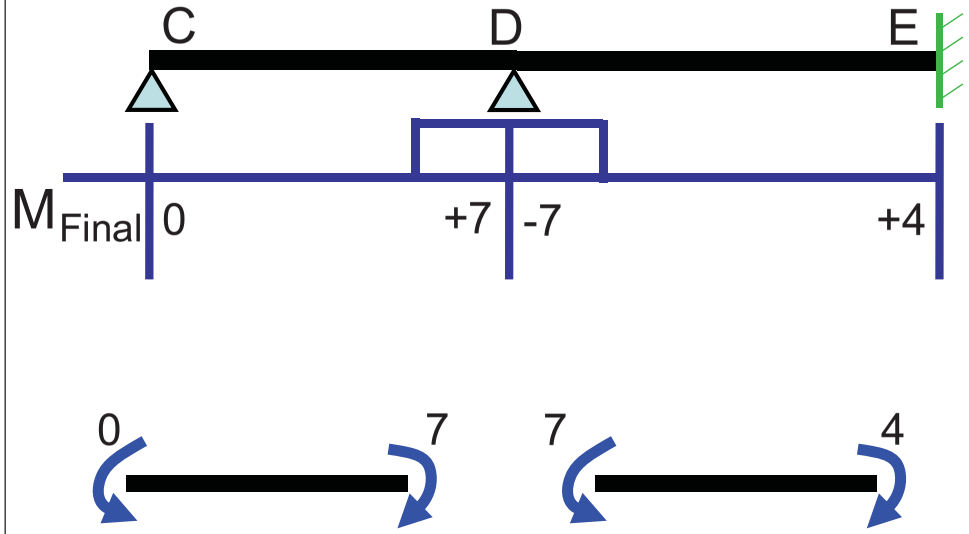
$$K_{CD} : K_{DE}$$

$$1 : 1$$

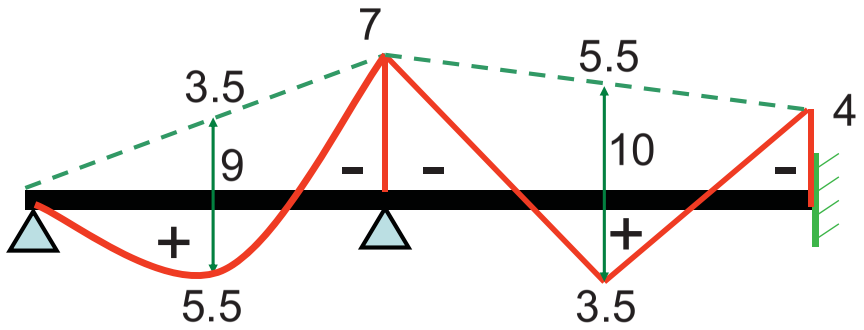
101



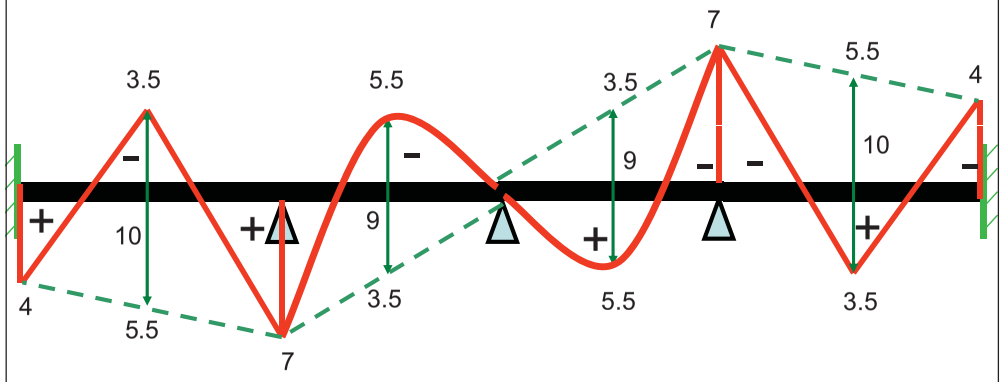
102



103



104

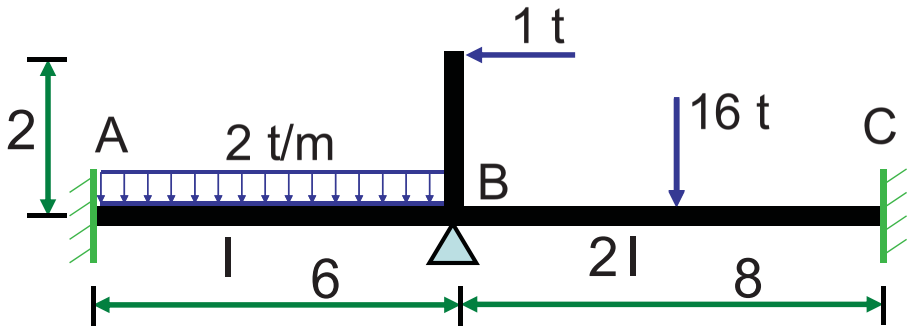


BMD

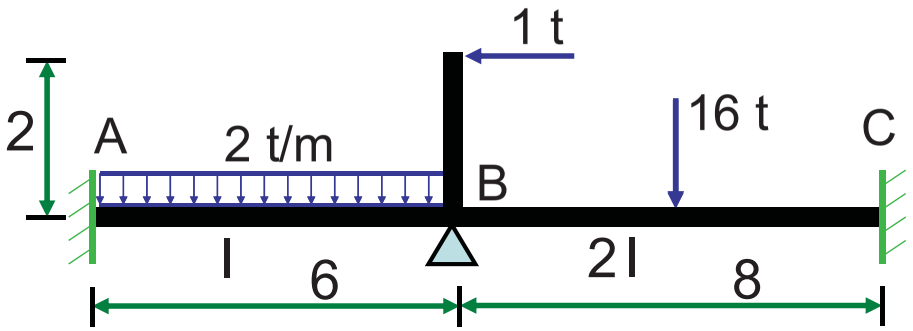
105

Example 10 :

Draw B.M.D for the shown beam



106

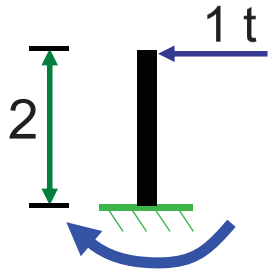


FEM :

$$M_{FAB} = \frac{wL^2}{12} = \frac{2\times 6^2}{12} = -6 \text{ tm} \qquad M_{FBA} = 6 \text{ tm}$$

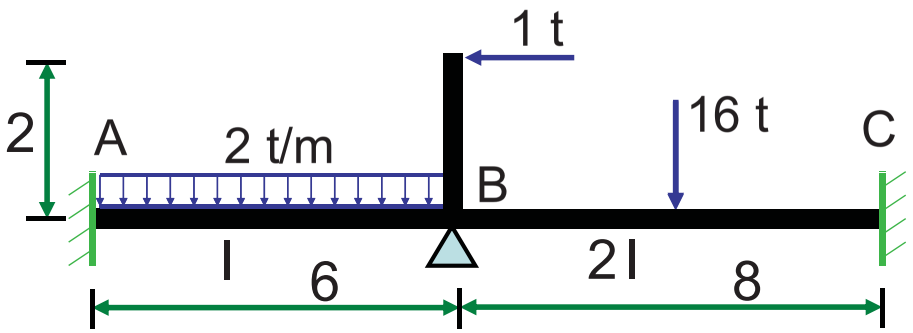
$$M_{FBC} = \frac{PL}{8} = \frac{16\times 8}{8} = -16 \text{ tm} \qquad M_{FCB} = 16 \text{ tm}$$

107



+2 tm

108



RS :

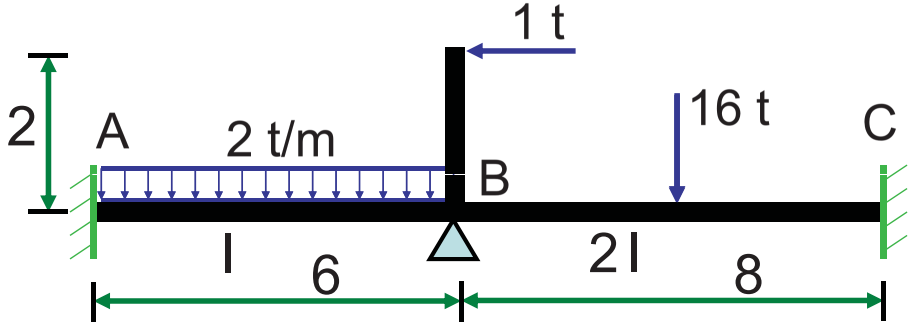
$$K_{AB} : K_{BC}$$

$$\frac{1}{6} : \frac{2}{8}$$

$$\frac{1}{6} : \frac{1}{4}$$

$$2 : 3$$

109



DF :

$$DF_{AB} : DF_{BC}$$

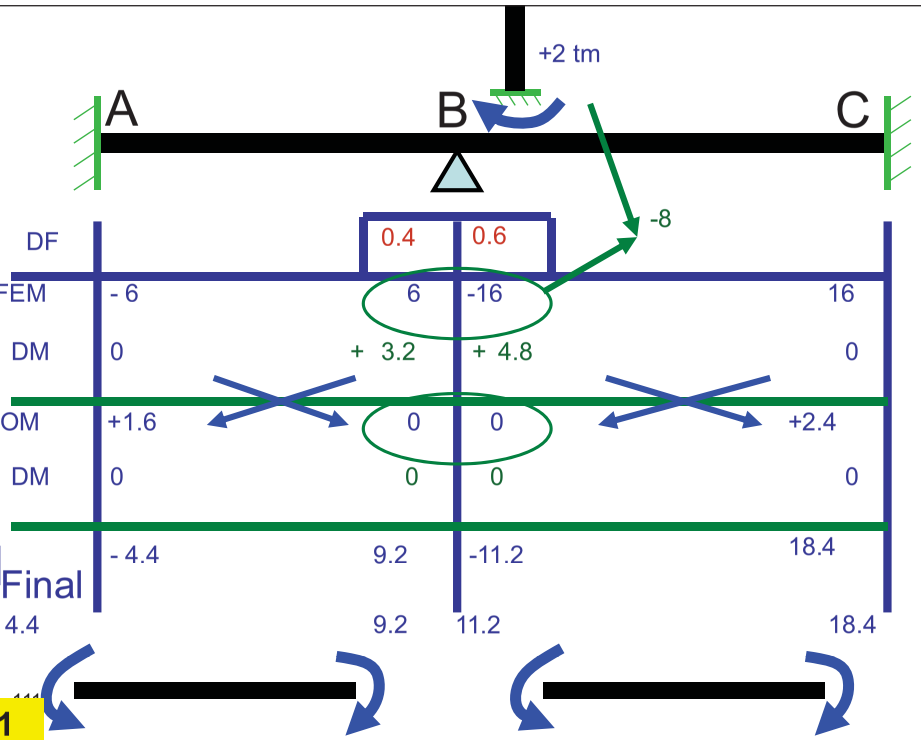
$$\frac{2}{2+3} : \frac{3}{2+3}$$

$$0.4 : 0.6$$

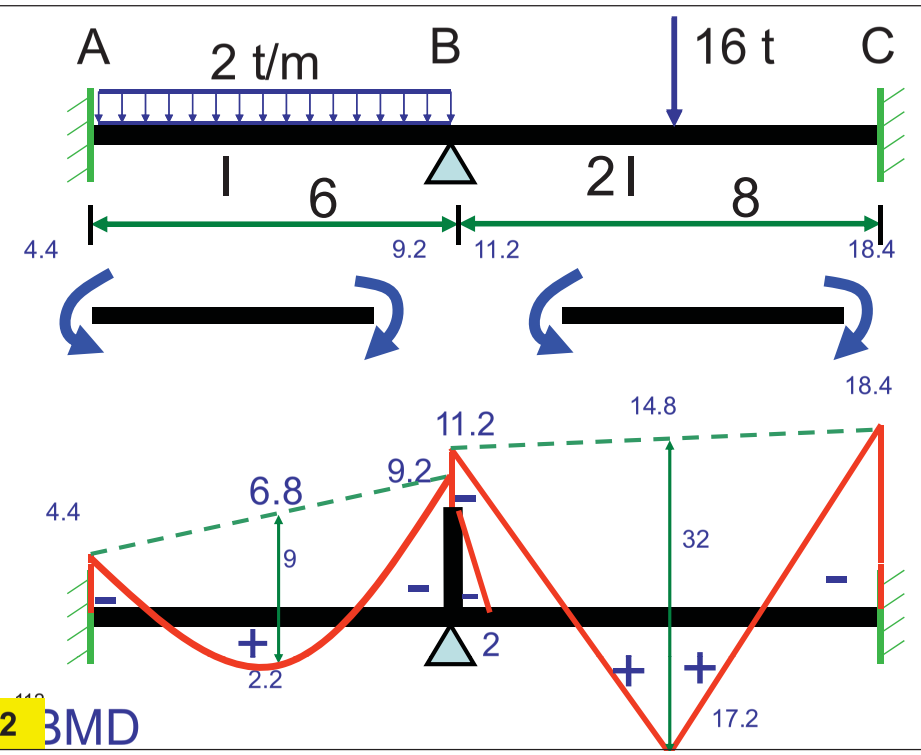
$$K_{AB} : K_{BC}$$

$$2 : 3$$

110



111



112 BMD

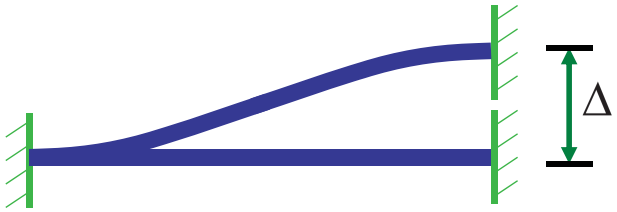
بســـم اللـــــه الرحمـــن الرحيـــم

Cont. Moment Distribution

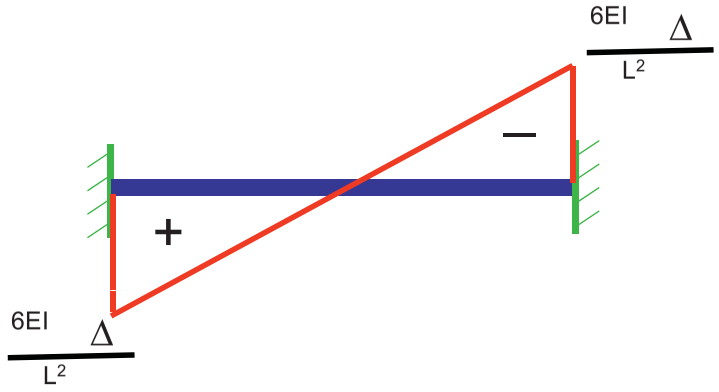
Beams & Frames

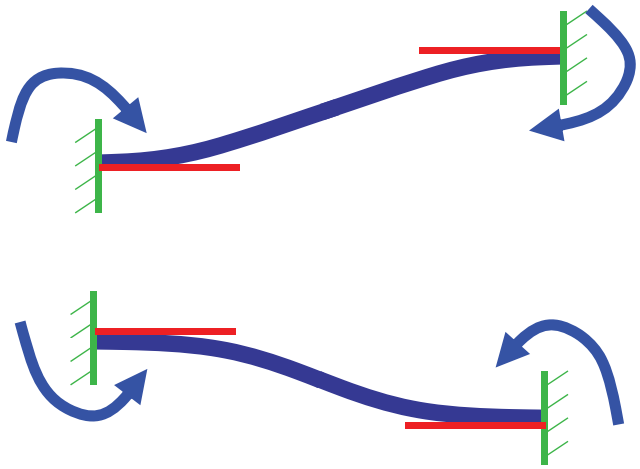
Beams with settlement

Fixed End Moment



$$M_A = \frac{6EI\ \Delta}{L^2}$$

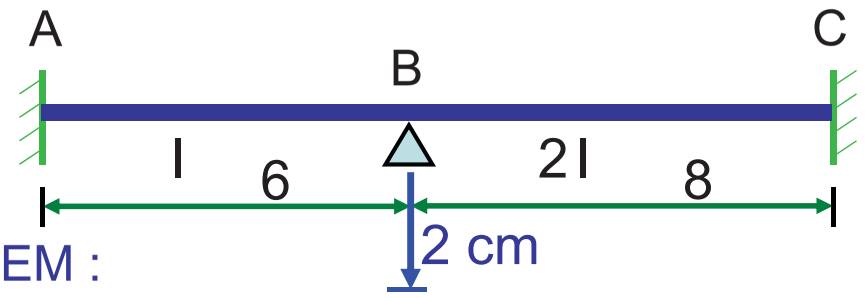




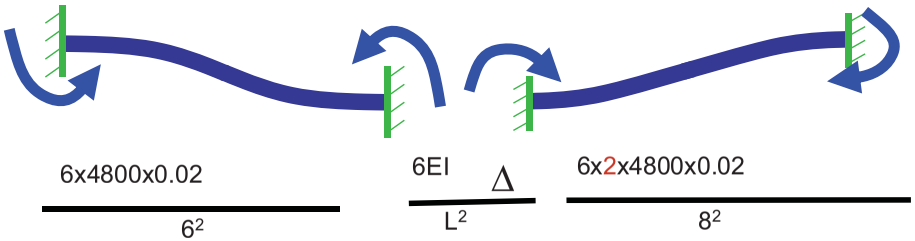
Example 16 :

EI=4800 t.m^2

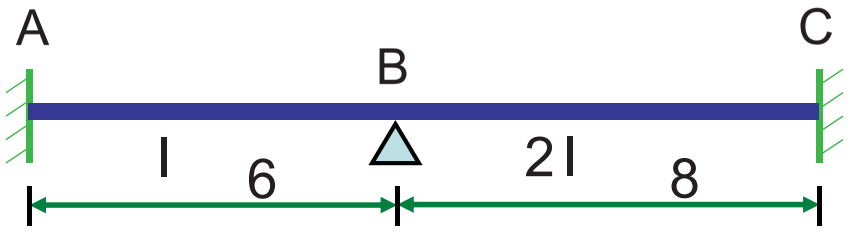
Draw B.M.D for the shown beam



FEM :

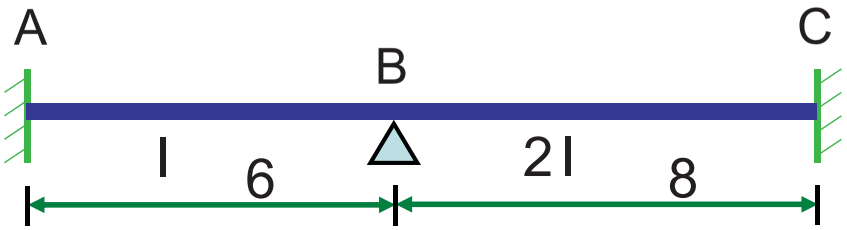


-16 18



RS :

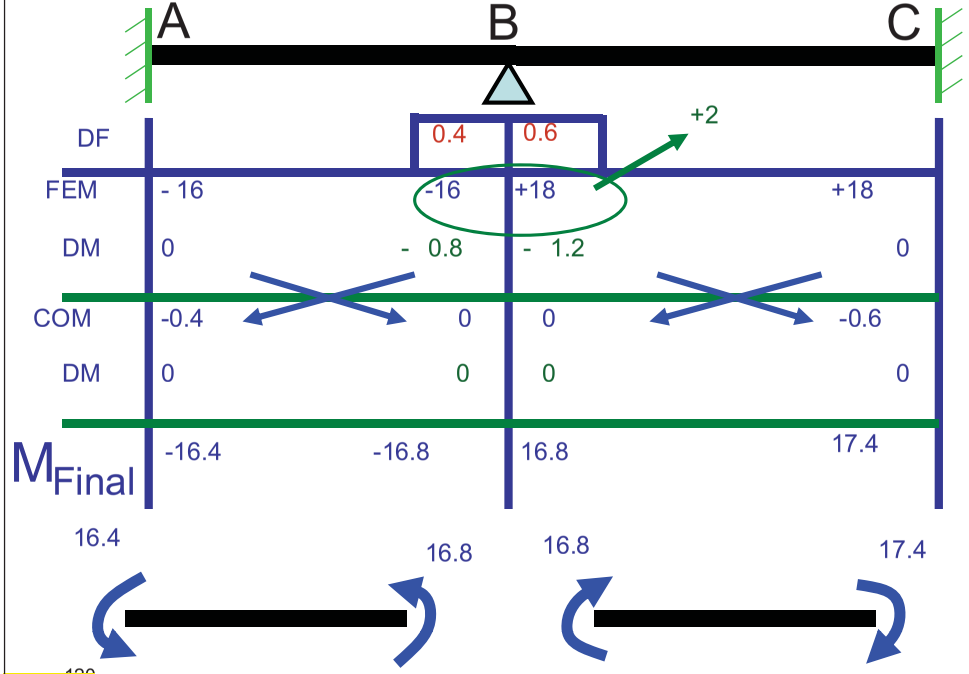
K_{AB}	:	K_{BC}
$\frac{1}{6}$	:	$\frac{2}{8}$
$\frac{1}{6}$	:	$\frac{1}{4}$
2	:	3

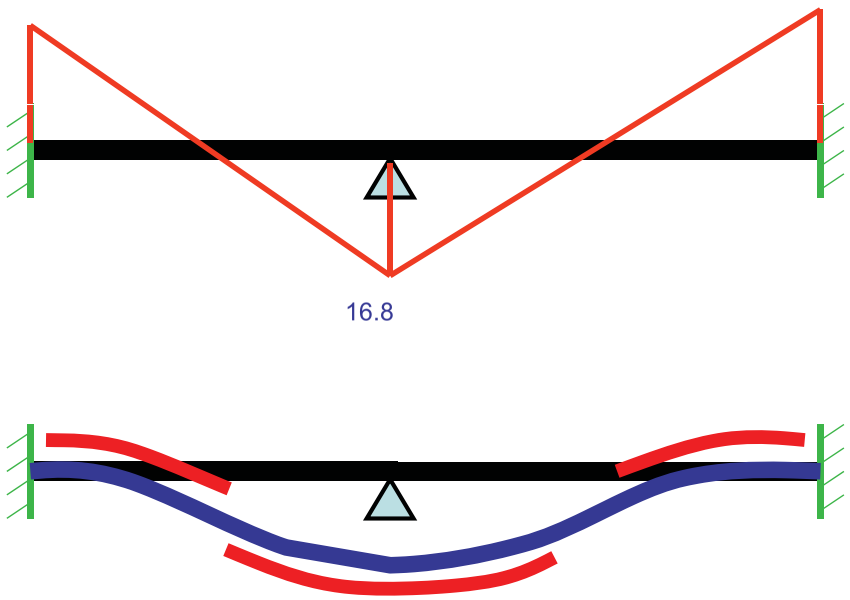


DF :

DF_{AB}	:	DF_{BC}
$\frac{2}{2+3}$	:	$\frac{3}{2+3}$
0.4	:	0.6

K_{AB}	:	K_{BC}
2	:	3



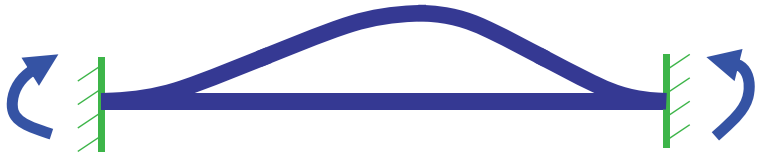


121

Beams with non uniform temp

Fixed End Moment

الدوران بيكون فى الاتجاه الاكبر للحرارة



$$M_A = \alpha EI \frac{T1-T2}{h} \qquad M_B = \alpha EI \frac{T1-T2}{h}$$

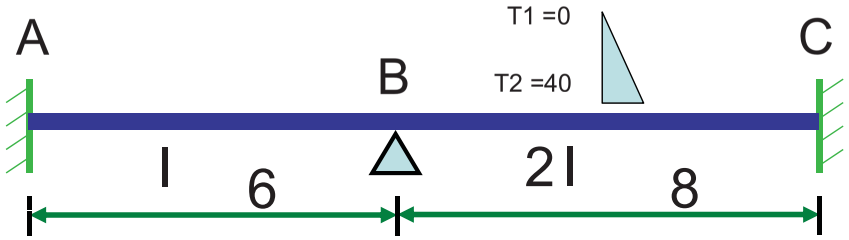
122

Example :

EI=4800 t.m²

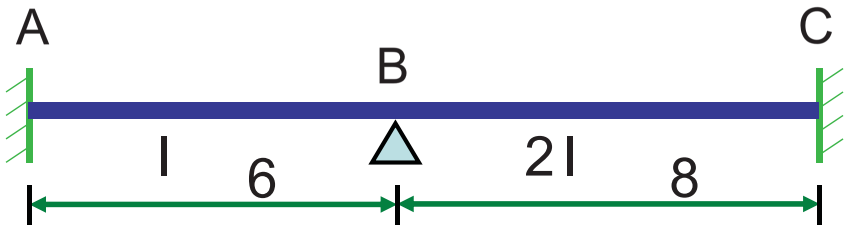
Draw B.M.D for the shown beam

α= 10*10^-5 h=0.8m



$$M = \alpha EI \frac{T1-T2}{h} = 24 \qquad M = \alpha EI \frac{T1-T2}{h} = 48$$

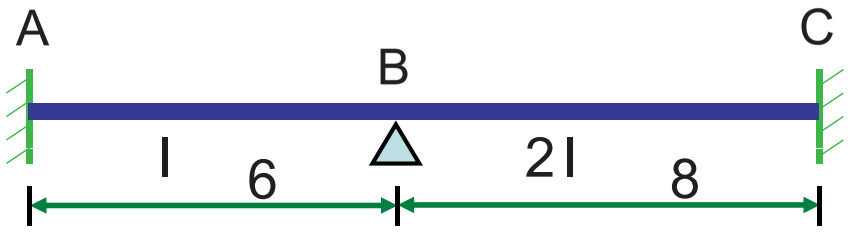
123



RS :

K_{AB}	:	K_{BC}
$\frac{1}{6}$	:	$\frac{2}{8}$
$\frac{1}{6}$	:	$\frac{1}{4}$
2	:	3

124



DF :

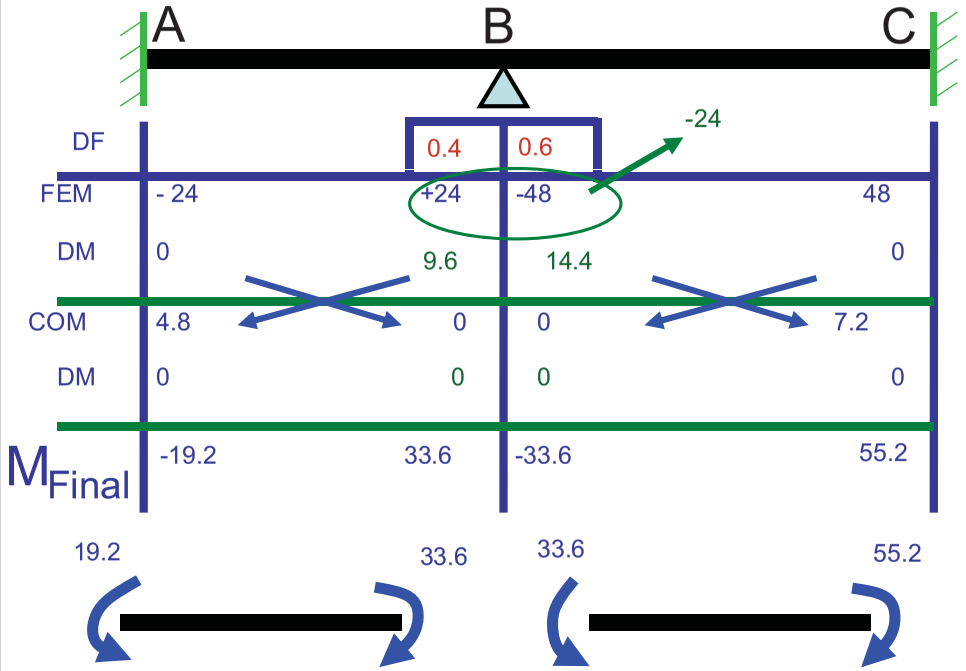
$$DF_{AB} : DF_{BC}$$

$$\frac{2}{2+3} : \frac{3}{2+3}$$

$$0.4 : 0.6$$

$$K_{AB} : K_{BC}$$

$$2 : 3$$



بســـم اللـــــه الرحمــن الرحيــم

Moment Distribution

Frames

Frames

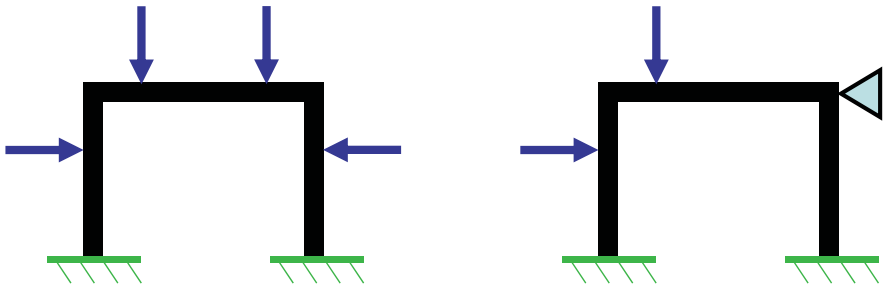
Without Sway

With Sway

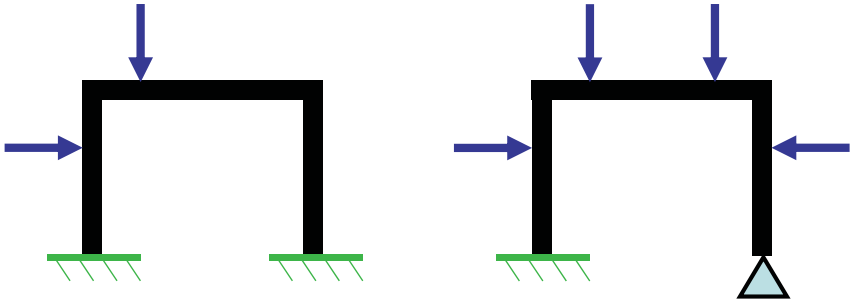
Without Sway Frames

Symmetry

With Support



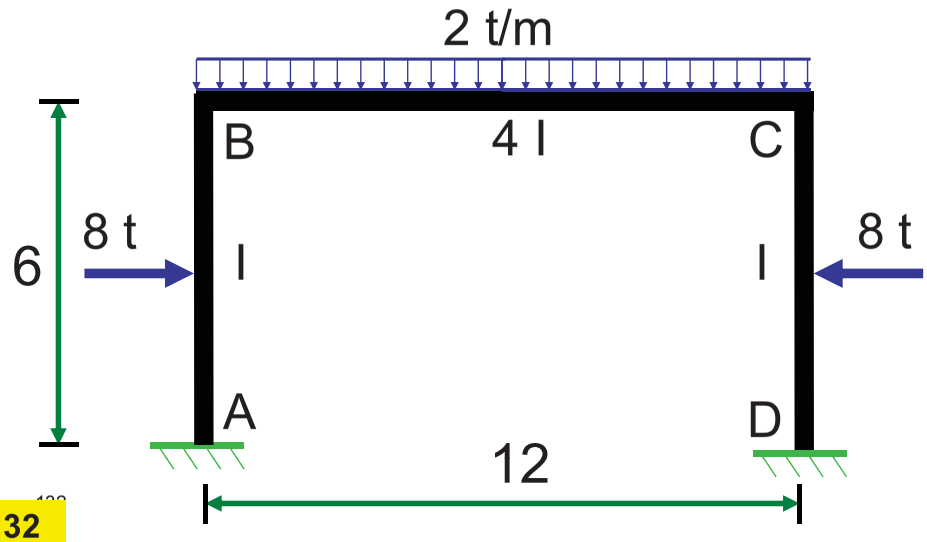
With Sway Frames

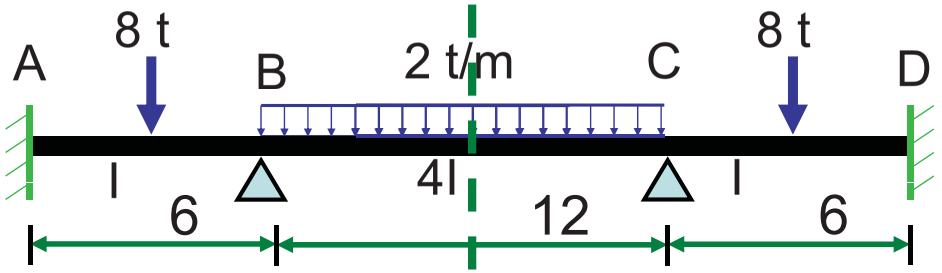


Frames without Sway

Example 11 :

Draw B.M.D, S.F.D and N.F.D for the shown frame



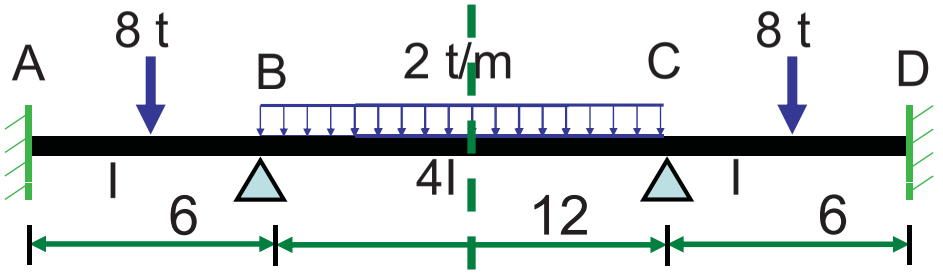


FEM :

$$M_{FAB} = \frac{PL}{8} = \frac{8\times 6}{8} = -6 \text{ tm} \qquad M_{FBA} = 6 \text{ tm}$$

$$M_{FBC} = \frac{wL^2}{12} = \frac{2\times 12^2}{12} = -24 \text{ tm}$$

133



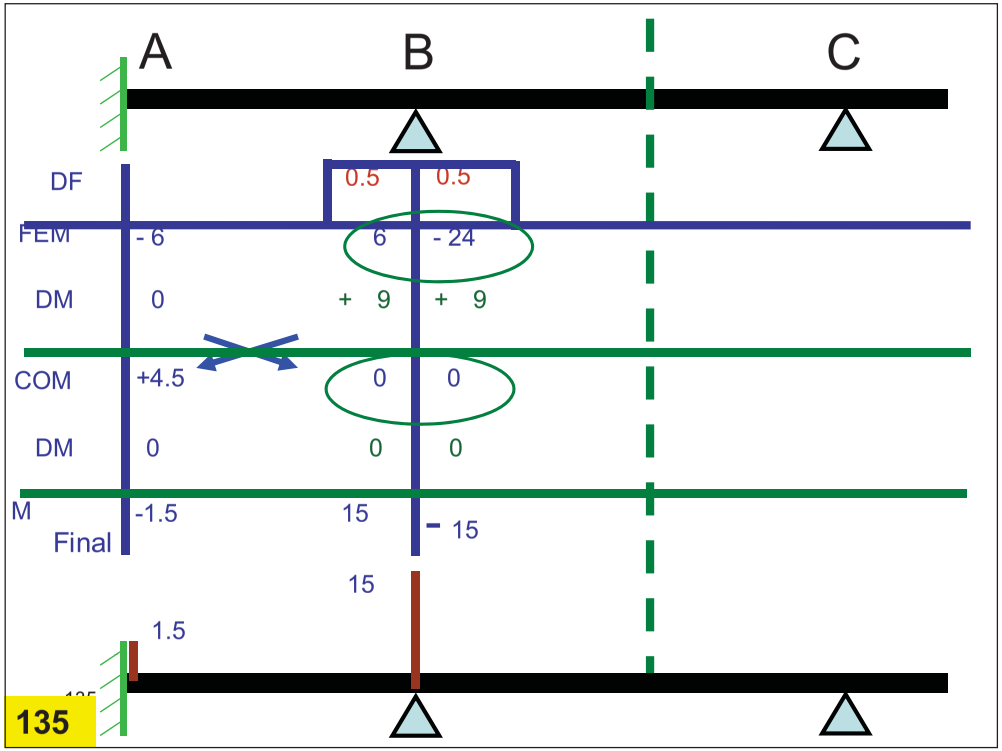
RS :

$$K_{AB} : K_{BC} = \frac{1}{6} : \frac{1}{2} x \frac{4}{12} = 1 : 1$$

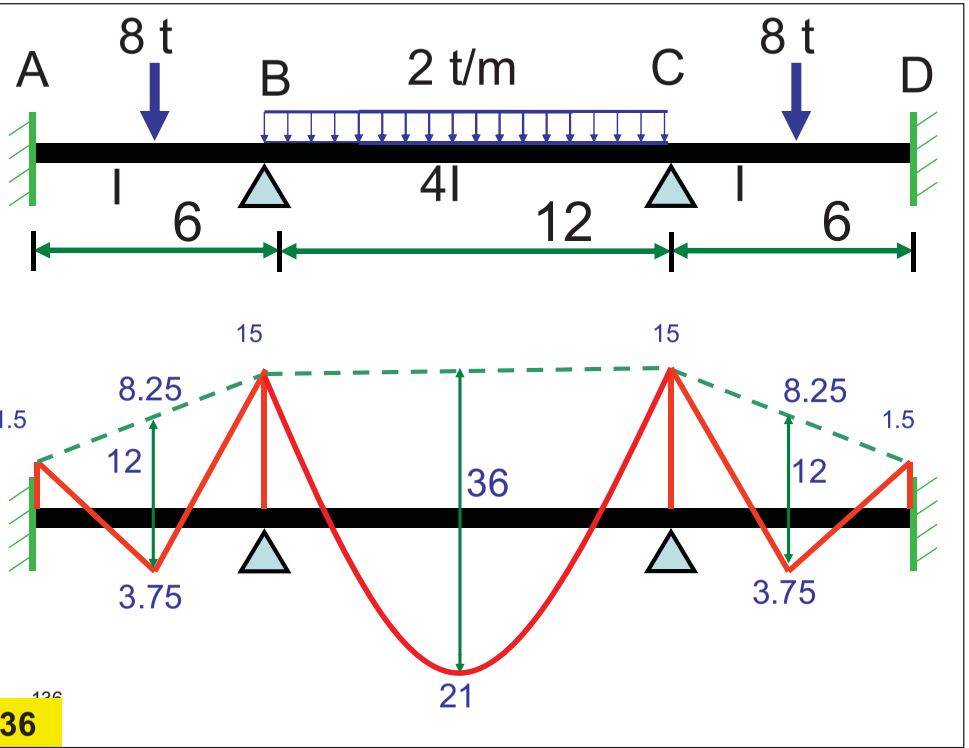
DF :

$$DF_{AB} : DF_{BC} = 0.5 : 0.5$$

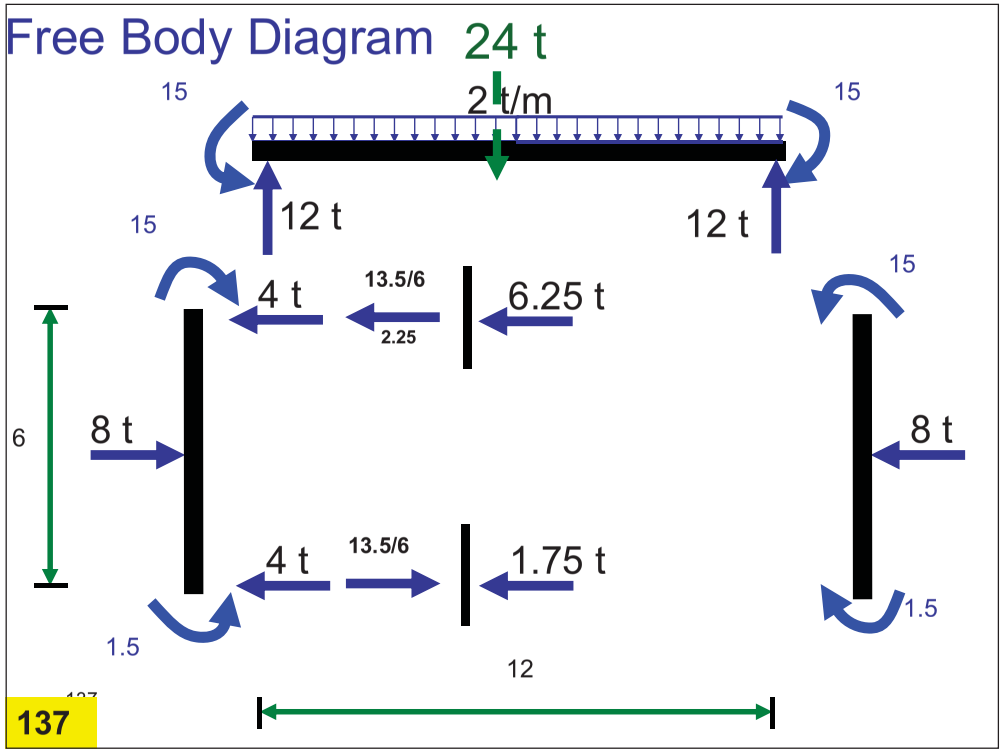
134

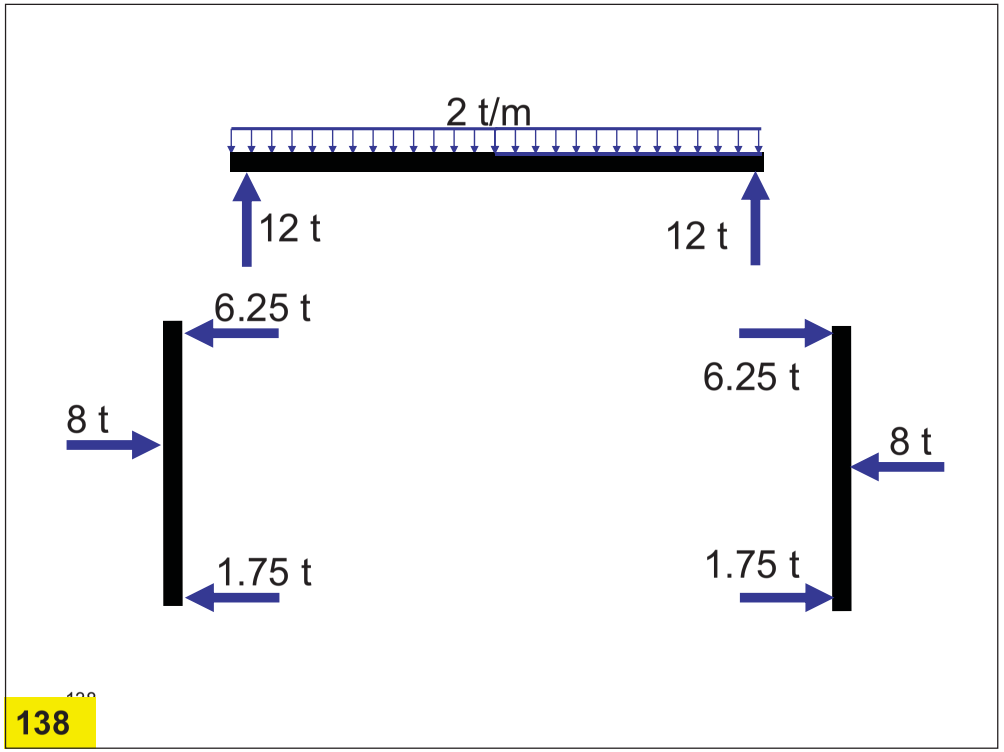


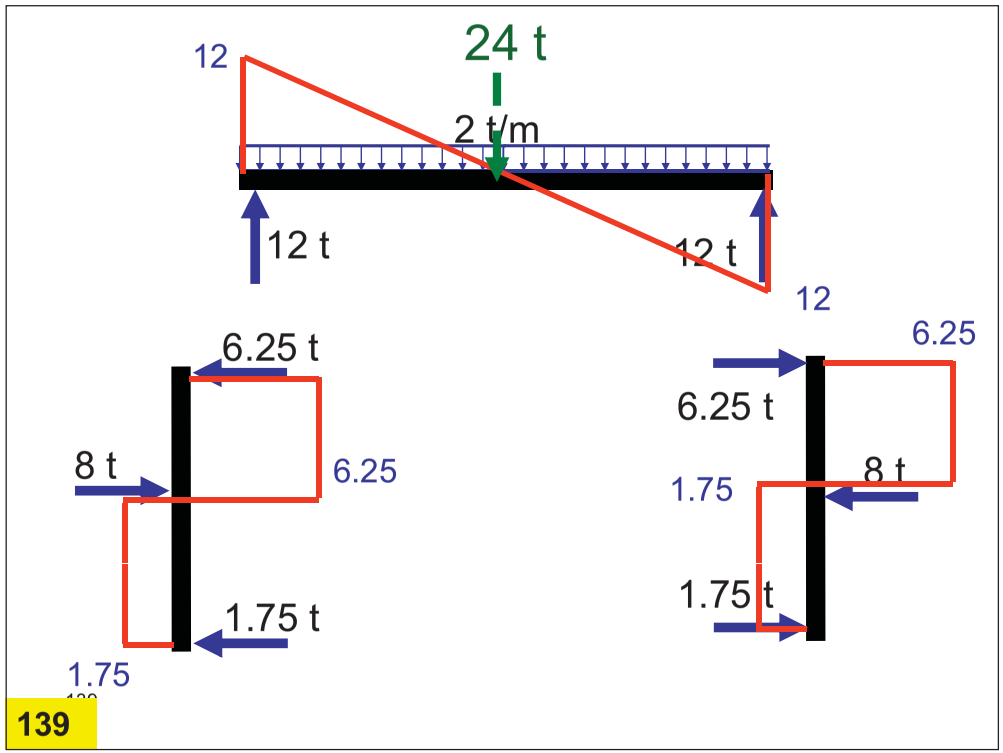
135

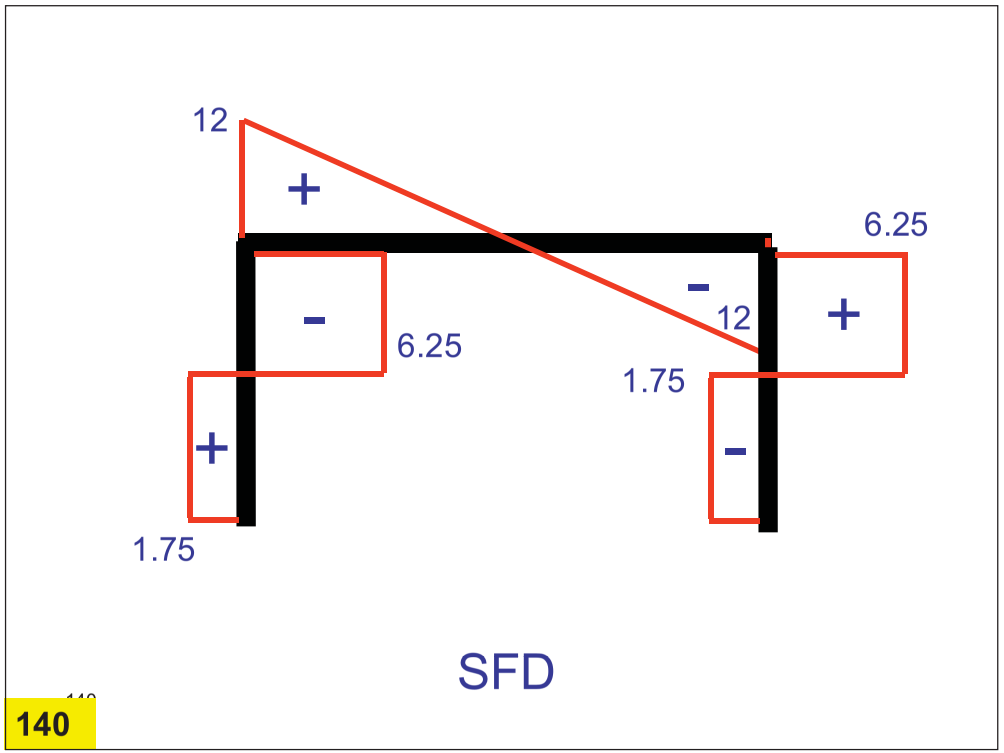


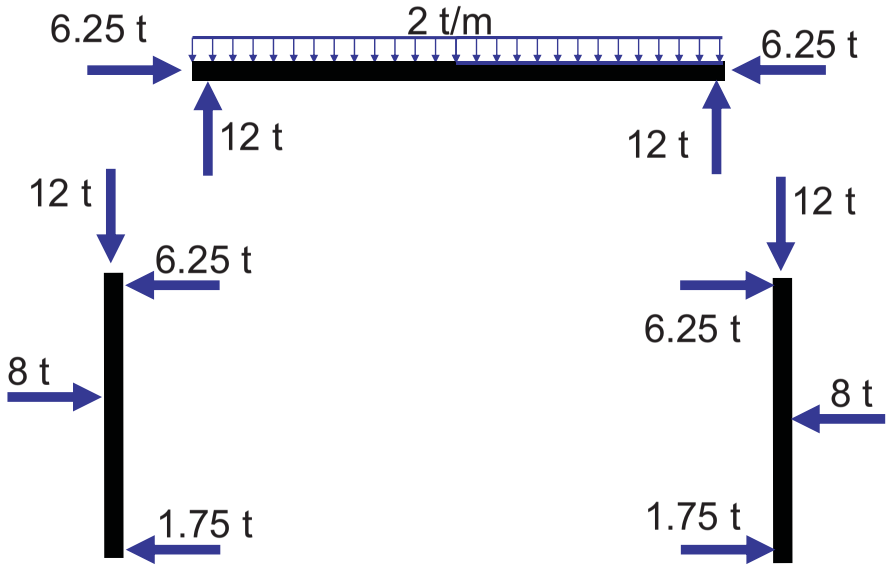
136


Free Body Diagram
24 t
2 t/m
15
15
15
15
12 t
12 t
4 t
13.5/6
2.25
6.25 t
8 t
8 t
6
4 t
13.5/6
1.75 t
1.5
1.5
12
137

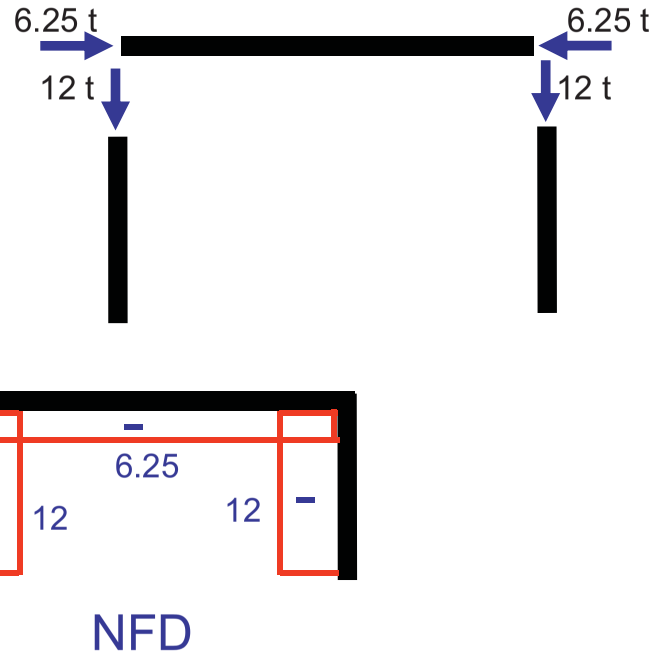

2 t/m
12 t
12 t
6.25 t
6.25 t
8 t
8 t
1.75 t
1.75 t
138


12
24 t
2 t/m
12 t
12 t
12
6.25
6.25 t
6.25 t
8 t
6.25
1.75
8 t
1.75 t
1.75 t
1.75
139


12
+
6.25
-
12
+
-
6.25
1.75
+
-
1.75
SFD
140



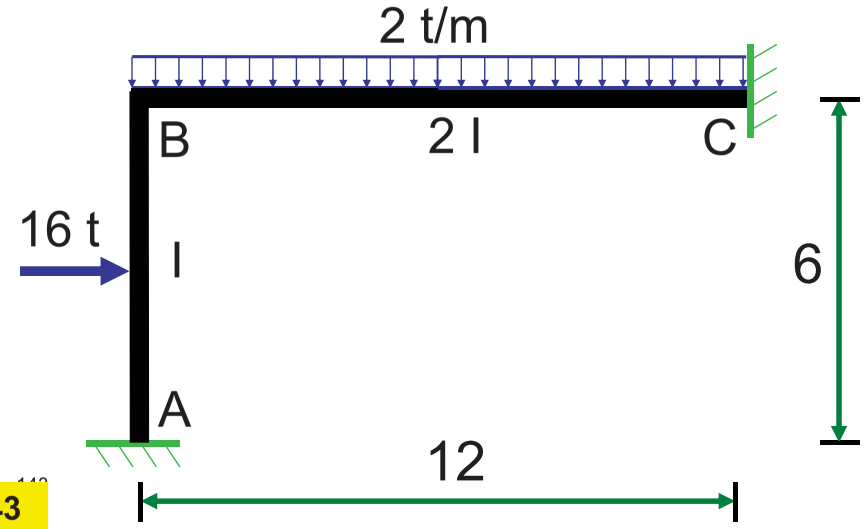
141



142

Example 12 :

Draw B.M.D for the shown frame



143

FEM :

$$M_{FAB} = \frac{PL}{8} = \frac{16\times 6}{8} = -12 \text{ tm} \qquad M_{FBA} = 12 \text{ tm}$$

$$M_{FBC} = \frac{wL^2}{12} = \frac{2\times 12^2}{12} = -24 \text{ tm} \qquad M_{FCB} = 24 \text{ tm}$$

RS :

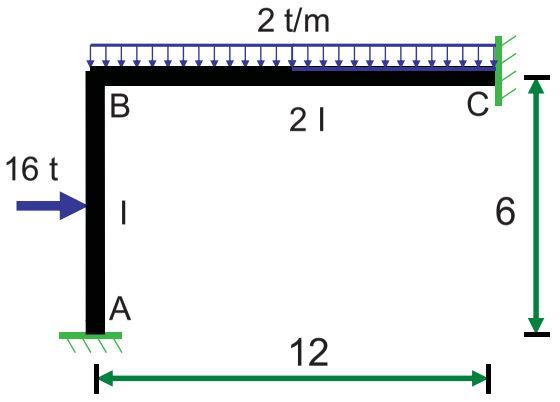
$K_{AB} : K_{BC}$

1 : 1

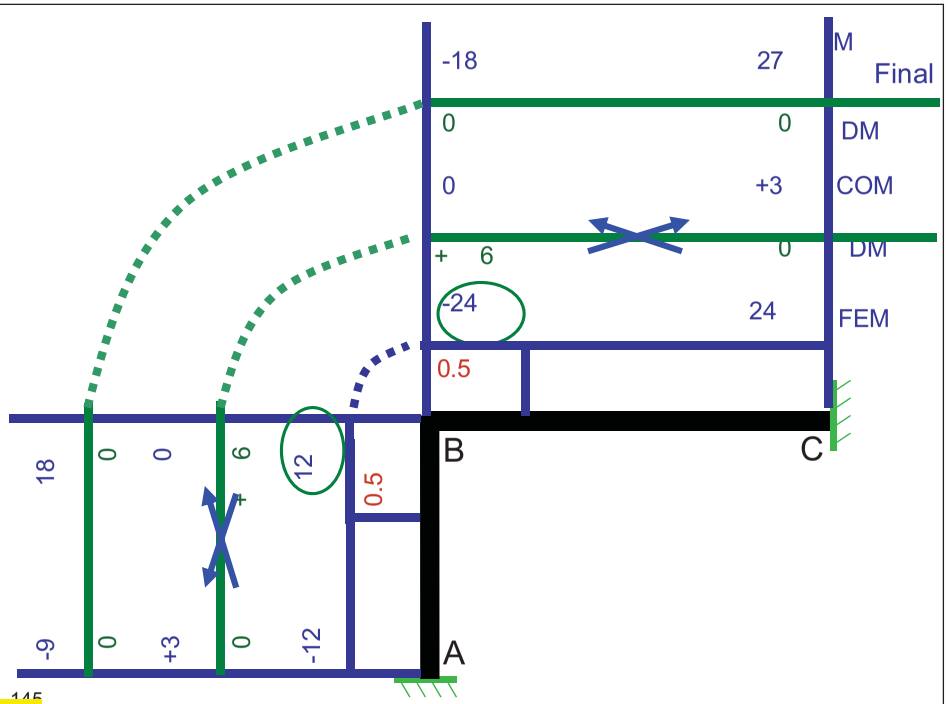
DF :

$DF_{AB} : DF_{BC}$

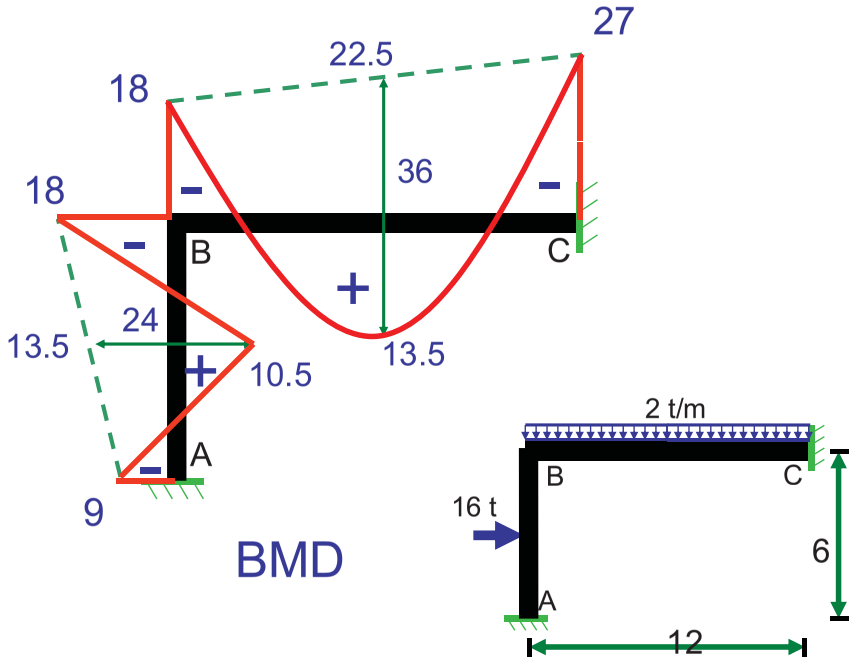
0.5 : 0.5



144



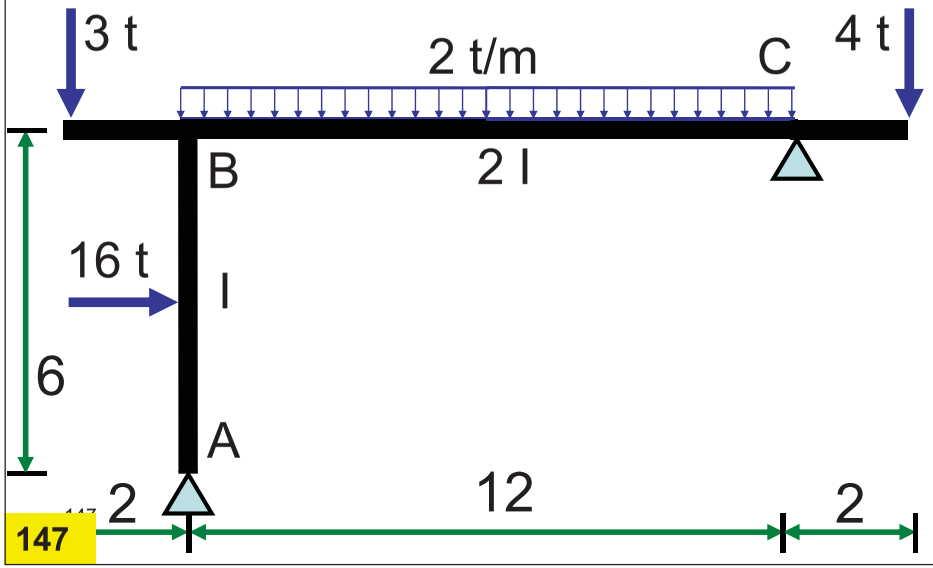
145



146

Example 13 :

Draw B.M.D for the shown frame



147

FEM :

$$M_{FAB} = \frac{PL}{8} = \frac{16\times 6}{8} = -12 \text{ tm} \qquad M_{FBA} = 12 \text{ tm}$$

$$M_{FBC} = \frac{wL^2}{12} = \frac{2\times 12^2}{12} = -24 \text{ tm} \qquad M_{FCB} = 24 \text{ tm}$$

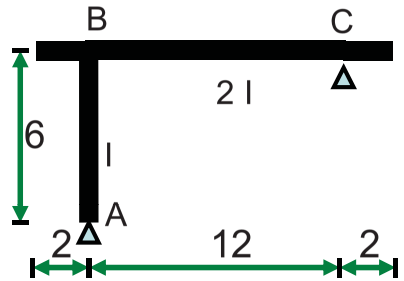
RS : $K_{AB} : K_{BC} = \frac{3}{4}x\frac{1}{6} : \frac{3}{4}x\frac{2}{12}$

1 : 1

DF :

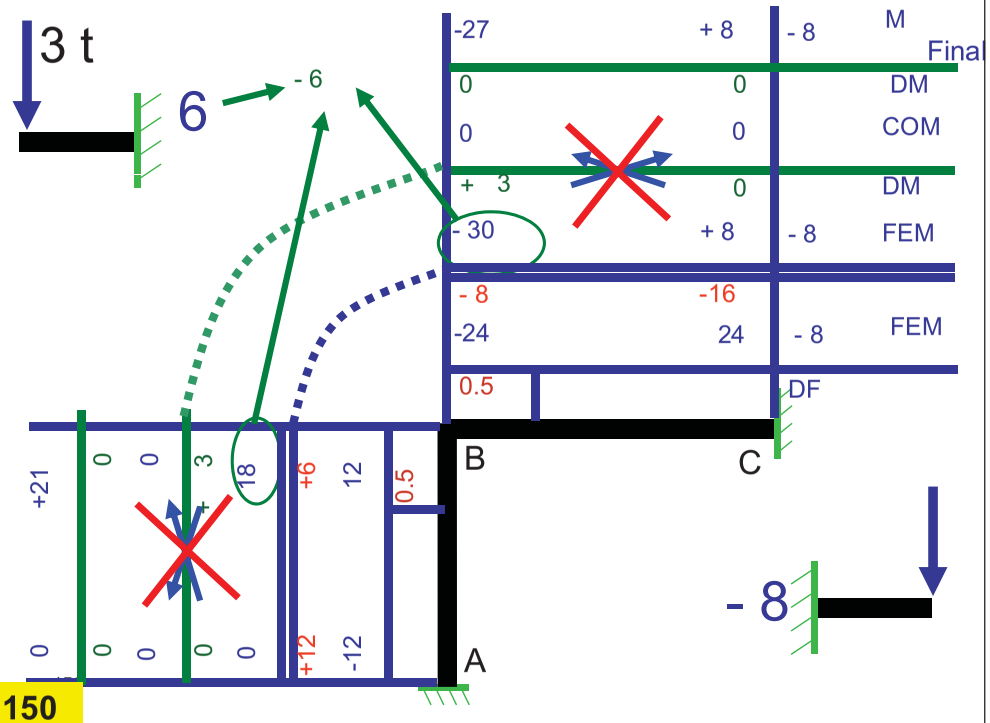
$DF_{AB} : DF_{BC}$

0.5 : 0.5

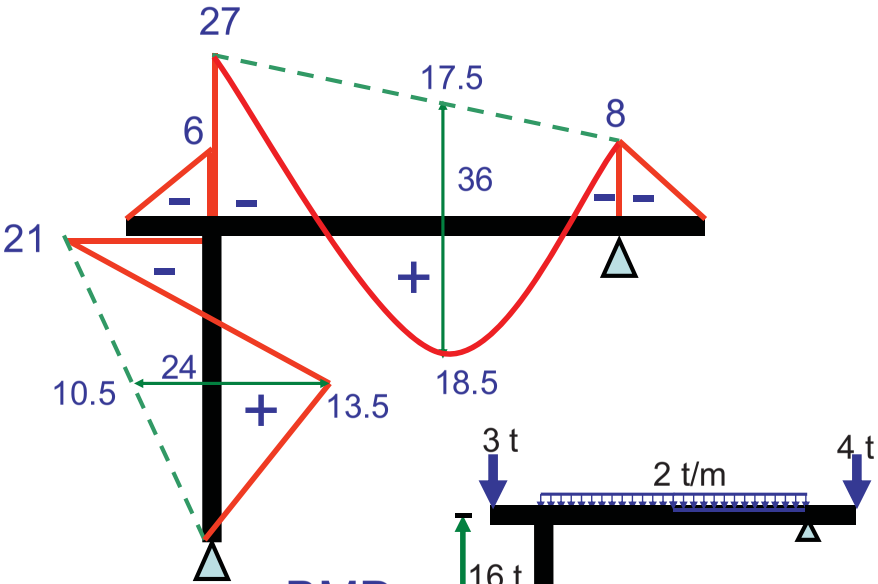


148

149



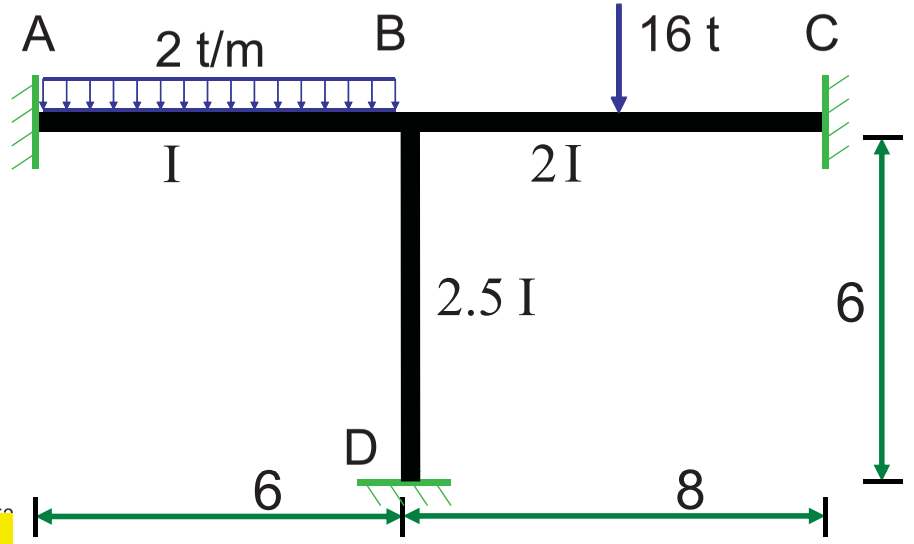
150



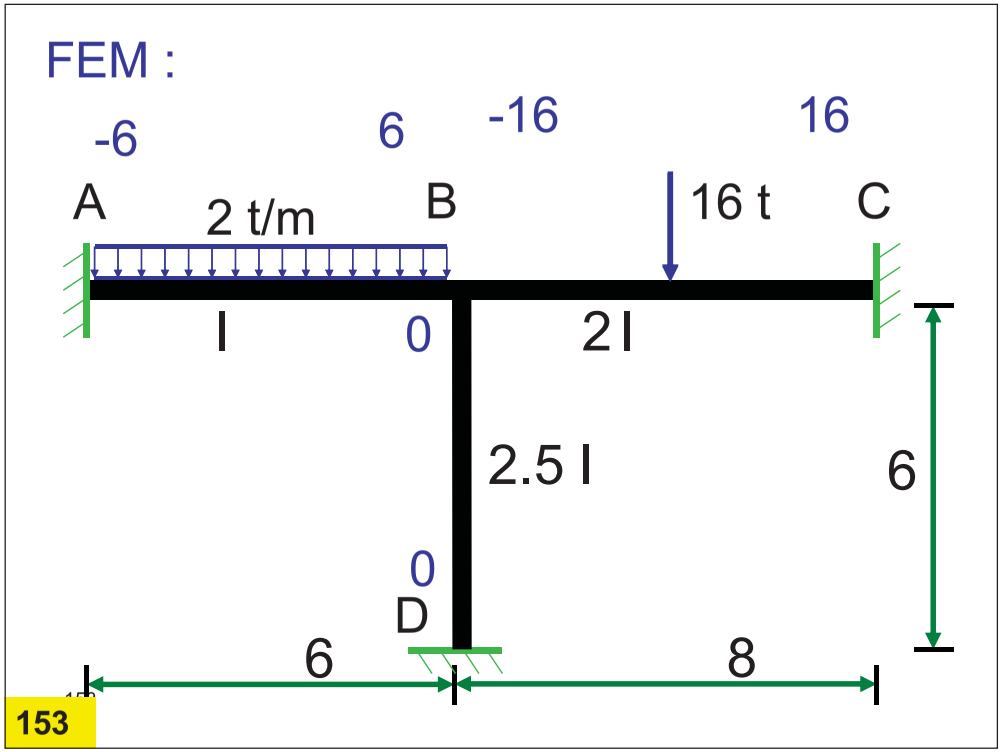
151

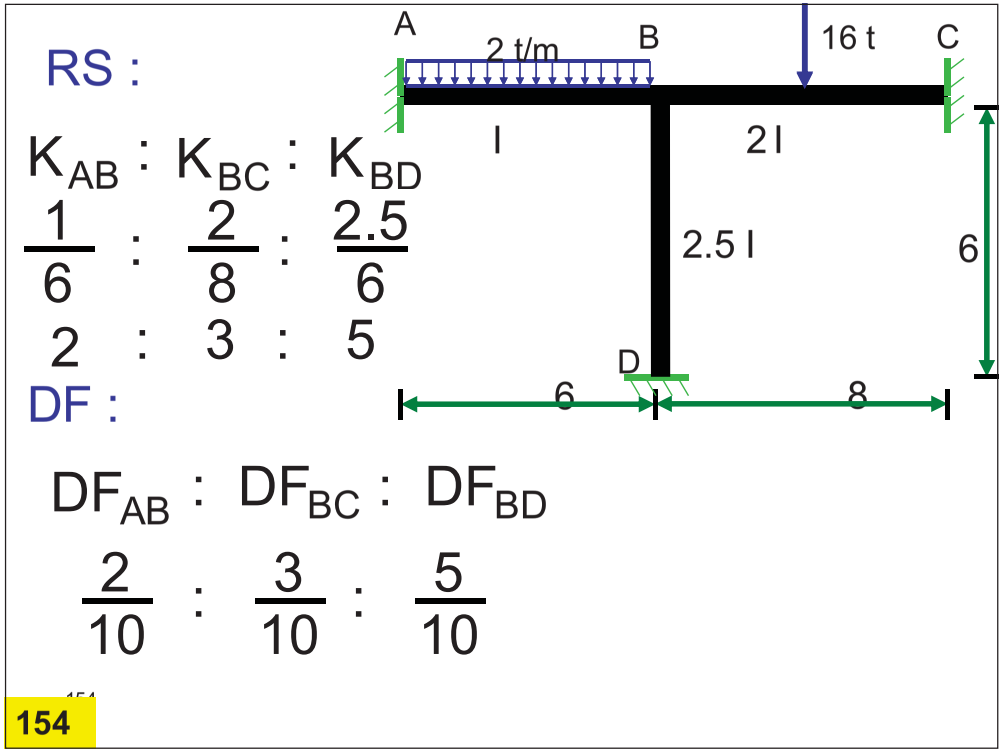
Example 14 :

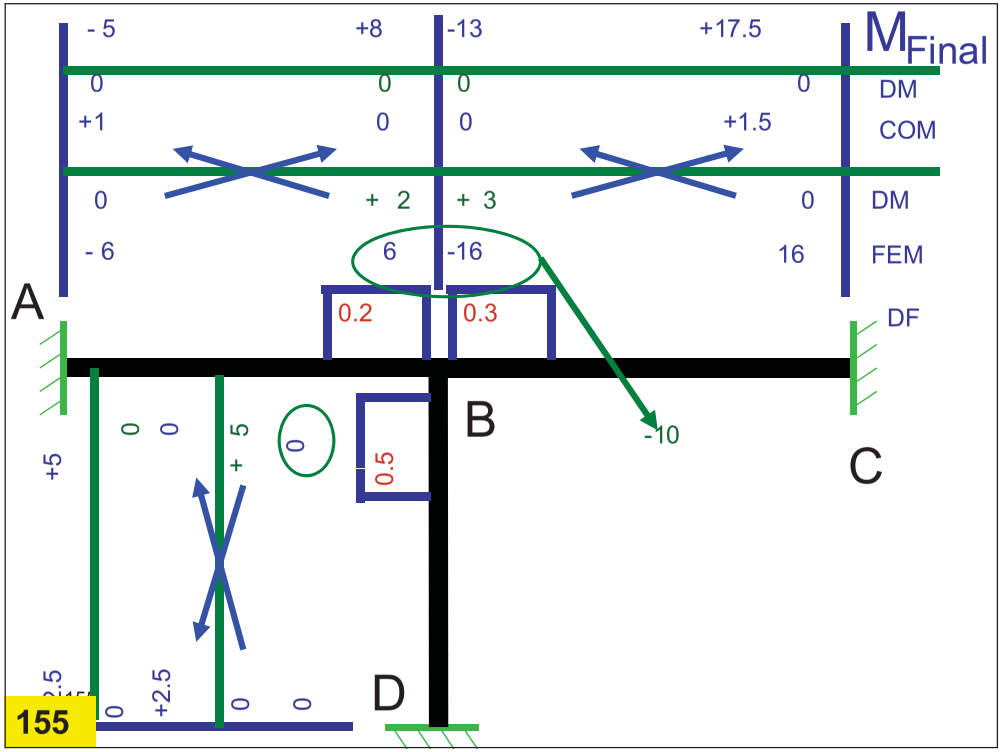
Draw B.M.D for the shown frame

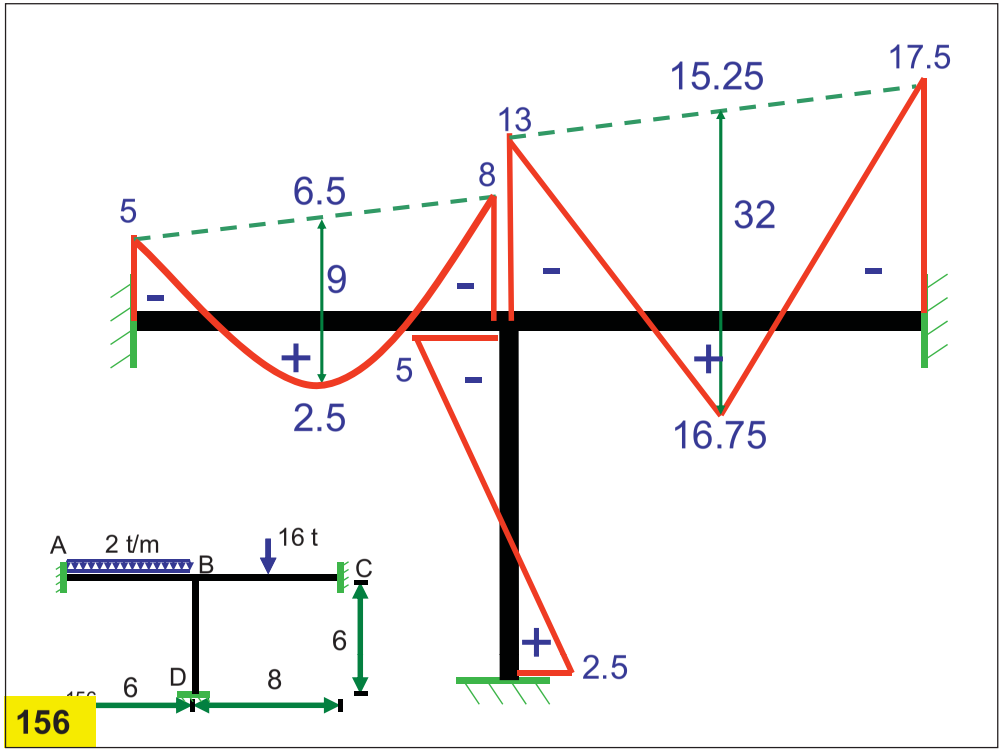


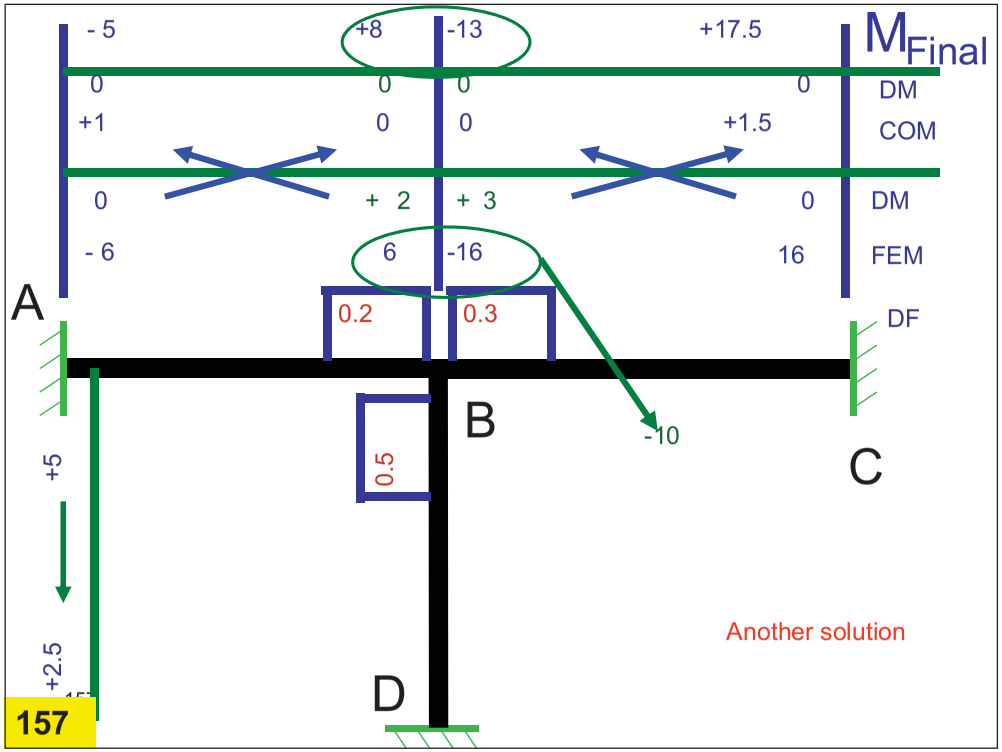
152


FEM :
-6
6
-16
16
A
2 t/m
B
16 t
C
I
0
2I
2.5 I
6
0
D
6
8
153


RS :
A
2 t/m
B
16 t
C
I
2I
2.5 I
6
D
6
8
$K_{AB} : K_{BC} : K_{BD}$
$\frac{1}{6} : \frac{2}{8} : \frac{2.5}{6}$
2 : 3 : 5
DF :
$DF_{AB} : DF_{BC} : DF_{BD}$
$\frac{2}{10} : \frac{3}{10} : \frac{5}{10}$
154


M_{Final}
- 5
+8
-13
+17.5
DM
+1
+1.5
COM
+ 2
+ 3
DM
- 6
6
-16
16
FEM
A
0.2
0.3
DF
B
-10
C
0.5
D
155


5
6.5
8
13
15.25
17.5
32
9
2.5
16.75
5
2.5
A
2 t/m
B
16 t
C
6
D
6
8
156



157

بسـم اللـه الرحمـن الرحيـم

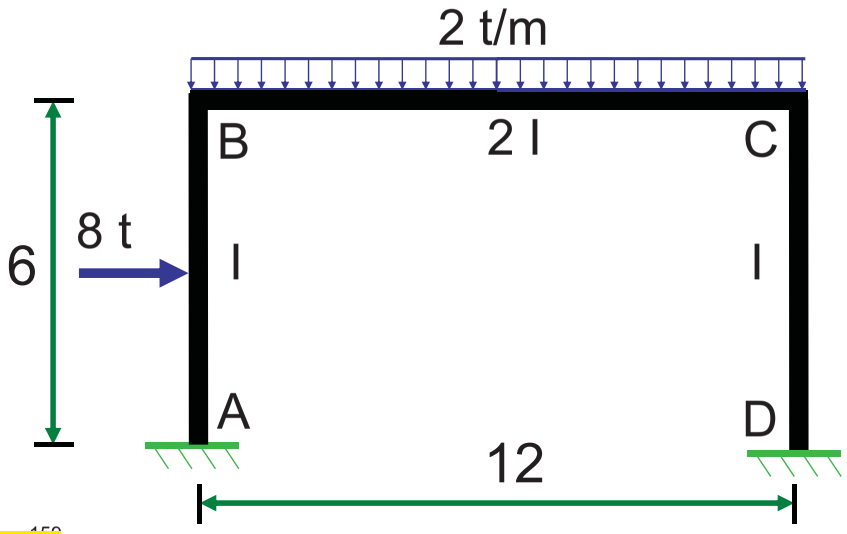
Moment Distribution

Frames with side sway

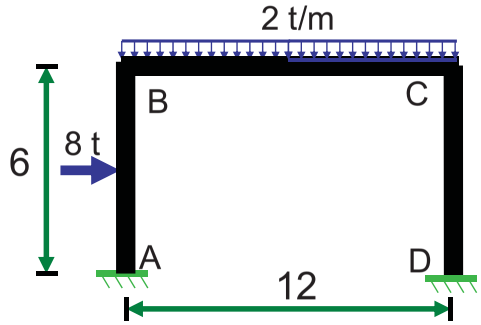
158

Example 17 :

Draw B.M.D & N.F.D and S.F.D for the shown frame



159



FEM :

$$M_{FAB} = \frac{PL}{8} = \frac{8\times 6}{8} = -6 \text{ tm} \qquad M_{FBA} = 6 \text{ tm}$$

$$M_{FBC} = \frac{wL^2}{12} = \frac{2\times 12^2}{12} = -24 \text{ tm}$$

$$M_{FCB} = 24 \text{ tm}$$

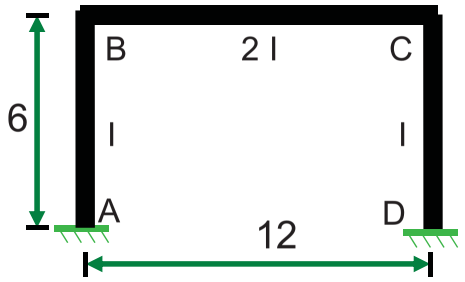
160

RS :

$K_{AB} : K_{BC} : K_{CD}$

$\frac{1}{6} : \frac{2}{12} : \frac{1}{6}$

$1 : 1 : 1$



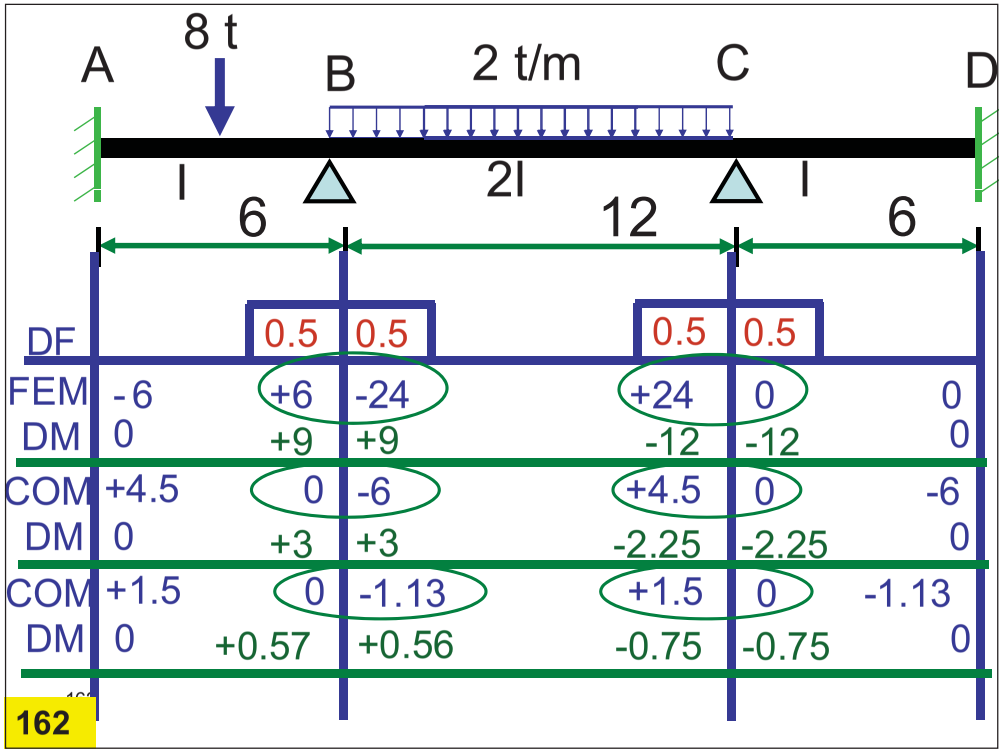
DF :

$DF_{BA} : DF_{BC}$

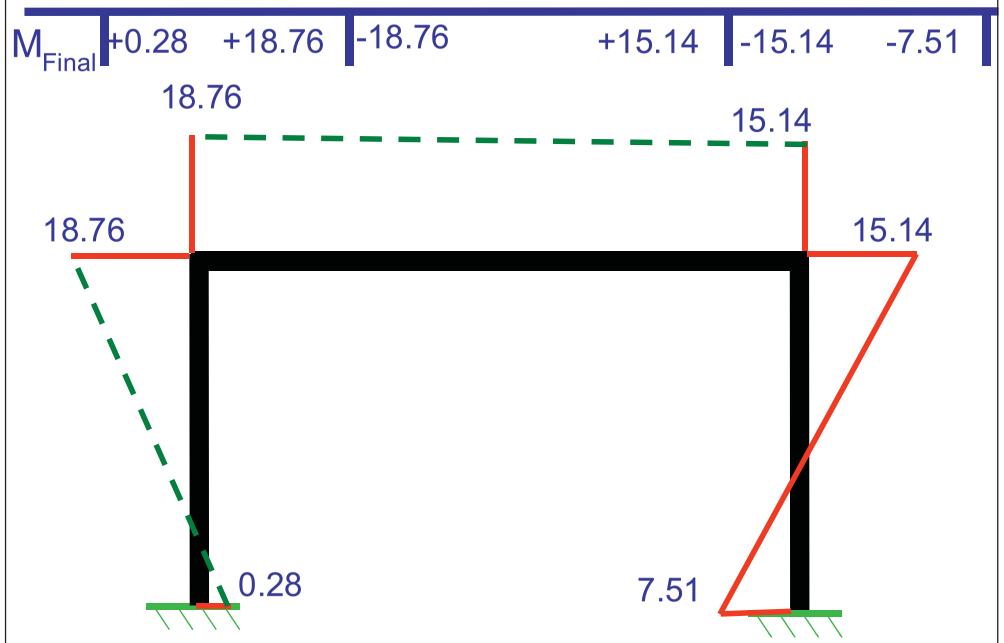
$\frac{1}{2} : \frac{1}{2}$

$DF_{CB} : DF_{CD}$

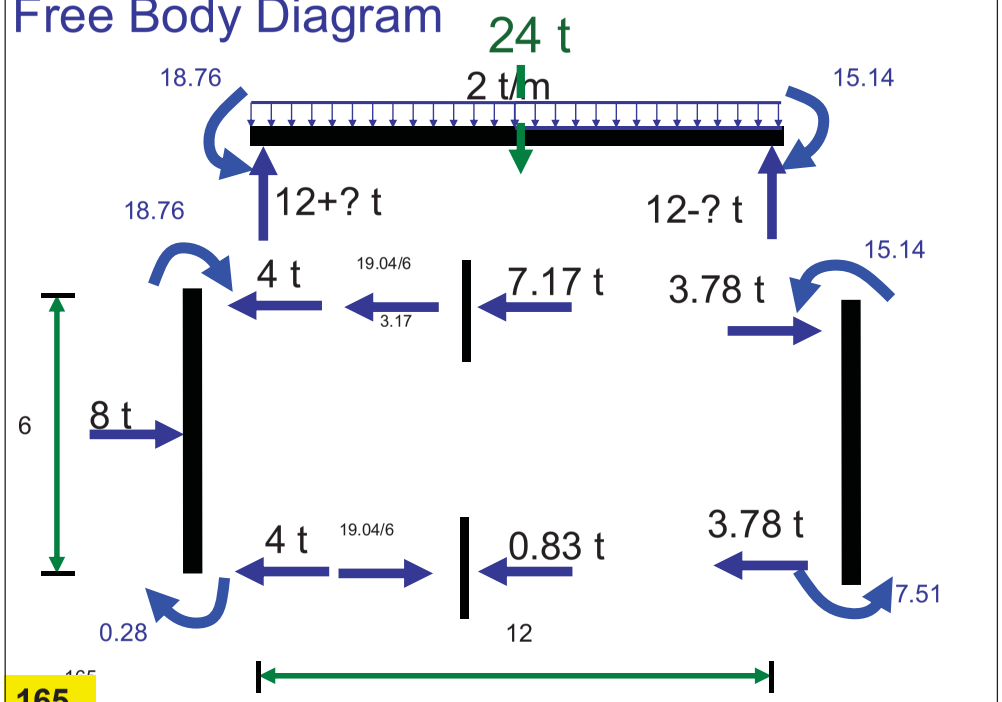
$\frac{1}{2} : \frac{1}{2}$



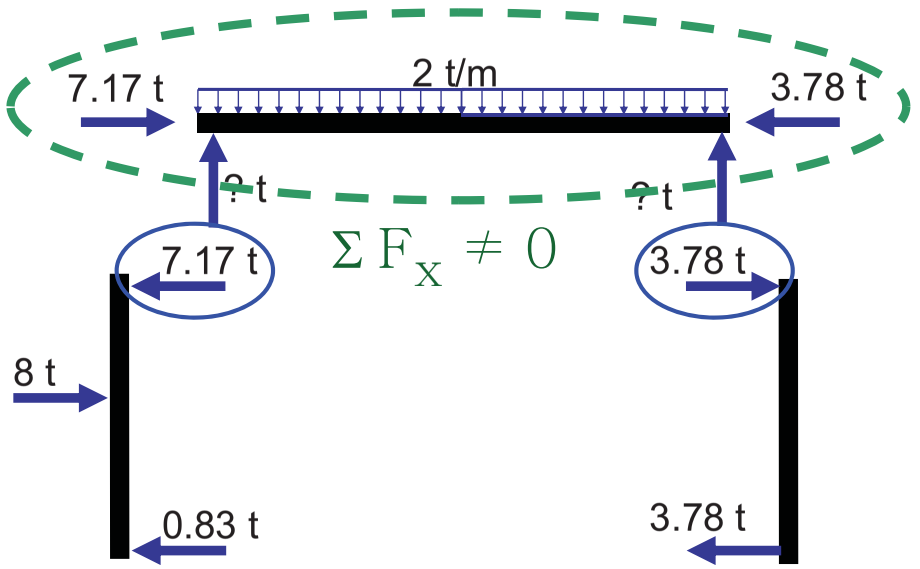
DF		0.5	0.5	0.5	0.5	
FEM	-6	+6	-24	+24	0	0
DM	0	+9	+9	-12	-12	0
COM	+4.5	0	-6	+4.5	0	-6
DM	0	+3	+3	-2.25	-2.25	0
COM	+1.5	0	-1.13	+1.5	0	-1.13
DM	0	+0.57	+0.56	-0.75	-0.75	0
COM	+0.28	0	-0.38	+0.28	0	-0.38
DM	0	+0.19	+0.19	-0.14	-0.14	0
M_{Fina}	+0.28	+18.76	-18.76	+15.14	-15.14	-7.51



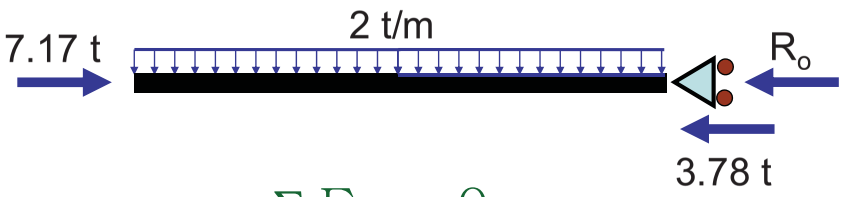
Free Body Diagram



Free Body Diagram



$\Sigma F_x \neq 0$

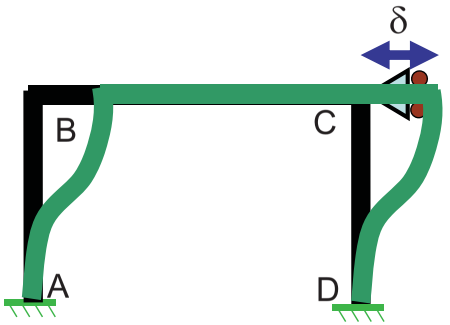


$$\Sigma F_x = 0$$

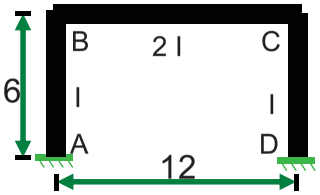
$$7.17 - 3.78 - R_o = 0$$

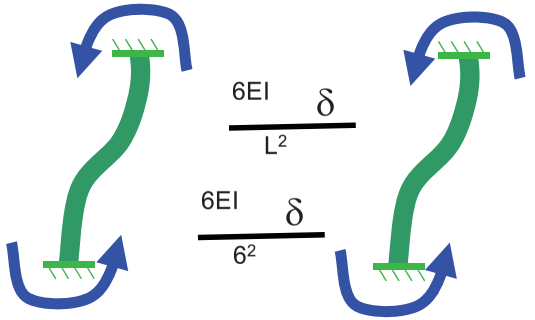
$$R_o = 3.39$$

Second Stage :



FEM :



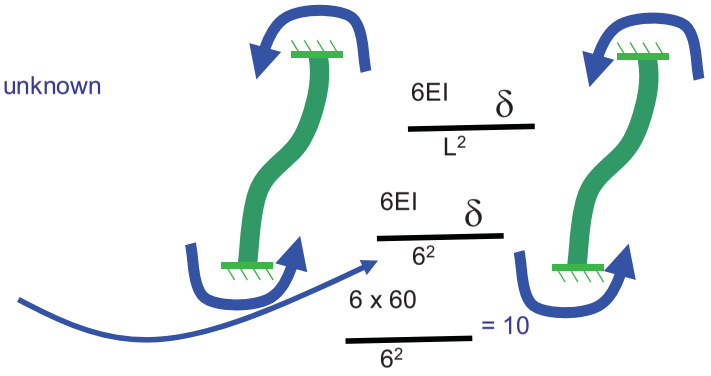


EI is unknown

δ is unknown

Assume :

EI δ = 60

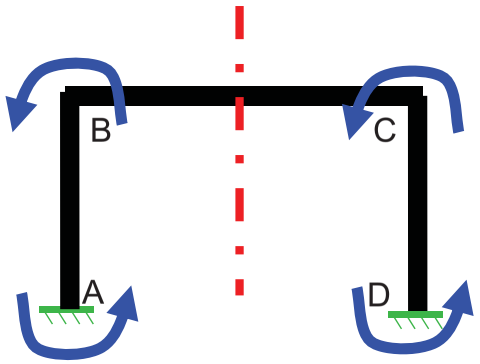


M_{FAB} = - 10 tm

M_{FCD} = - 10 tm

M_{FBA} = - 10 tm

M_{FDC} = - 10 tm



solved as anti-symmetry problem

RS :

$K_{AB} : K_{BC}$

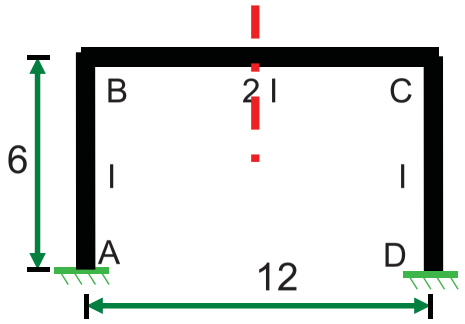
$\frac{1}{6} : \frac{3}{2} \times \frac{2}{12}$

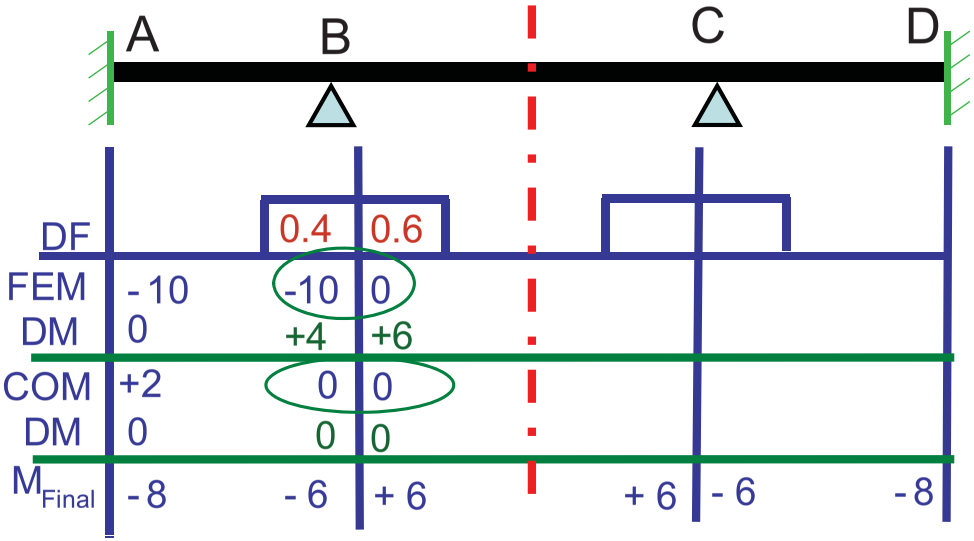
2 : 3

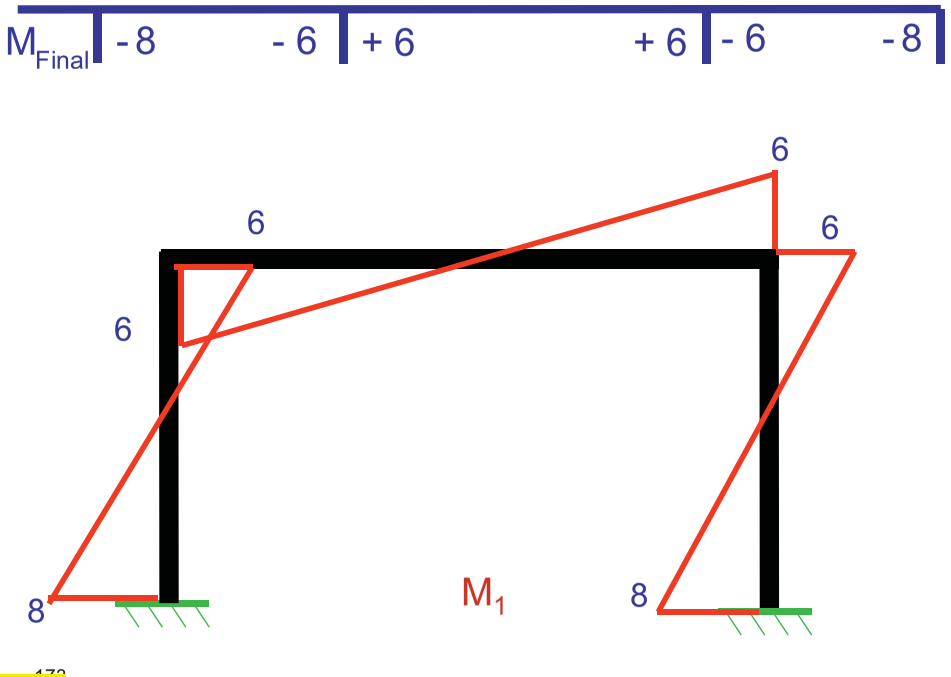
DF :

$DF_{BA} : DF_{BC}$

$\frac{2}{5} : \frac{3}{5}$

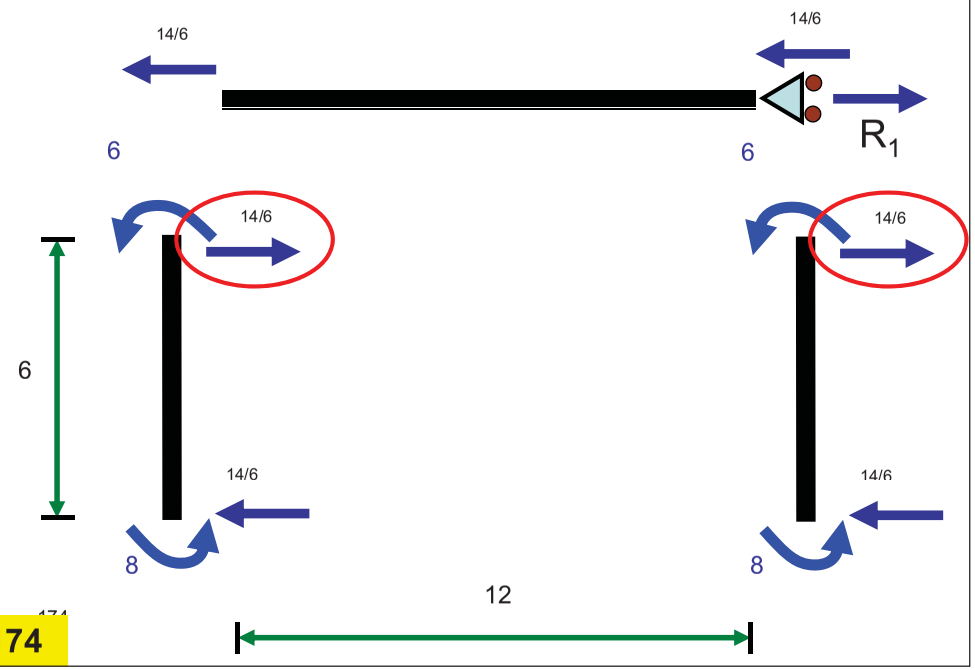






173

Free Body Diagram



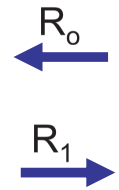
174

$$\Sigma F_x = 0$$

$$14/6 + 14/6 - R_1 = 0$$

$$R_1 = 14/3$$

175



$$R_o = 3.39$$

$$R_1 = 14 / 3$$

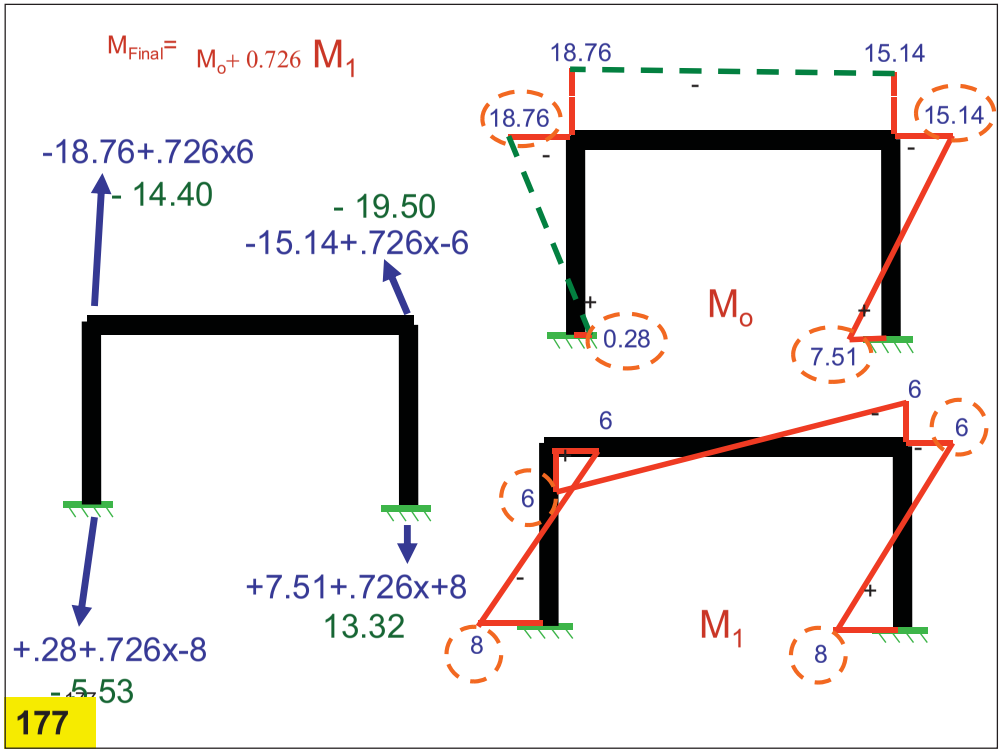
$$R_{Final} = R_o - \Delta R_1 = 0$$

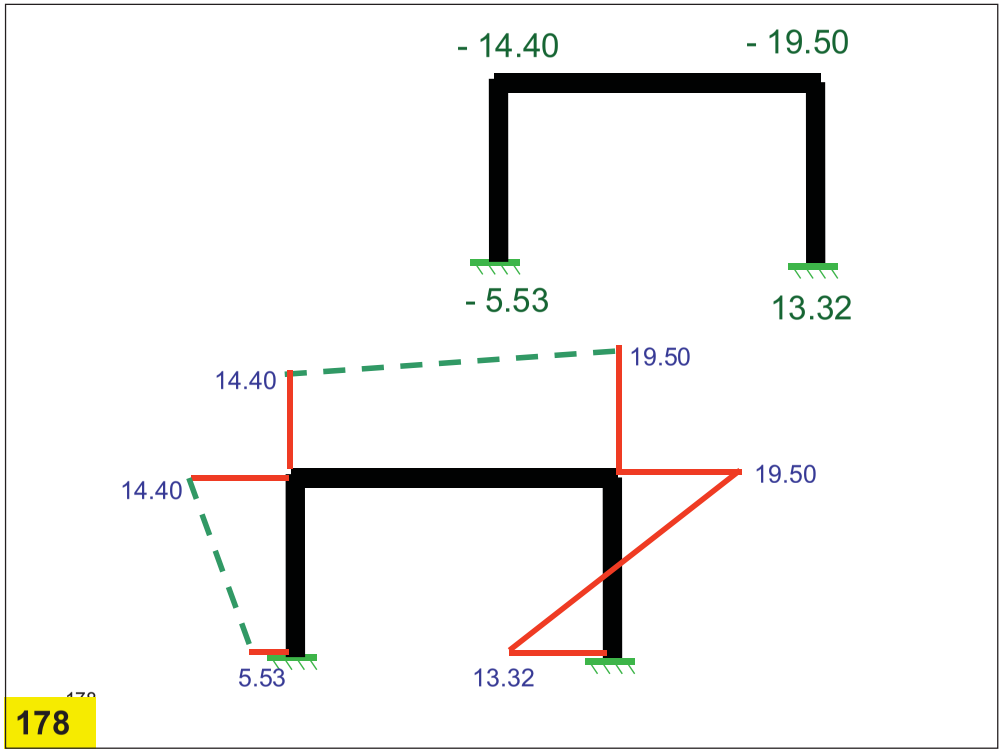
$$R_o = \Delta R_1$$

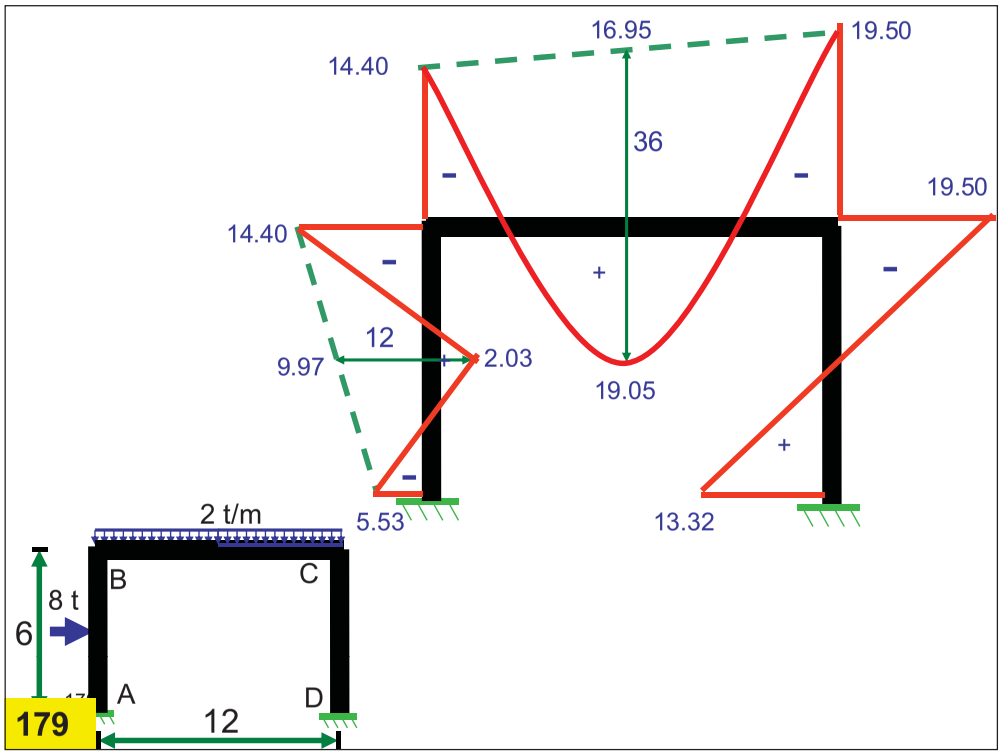
$$\Delta = \frac{R_o}{R_1} = \frac{3.39}{14 / 3} = 0.726$$

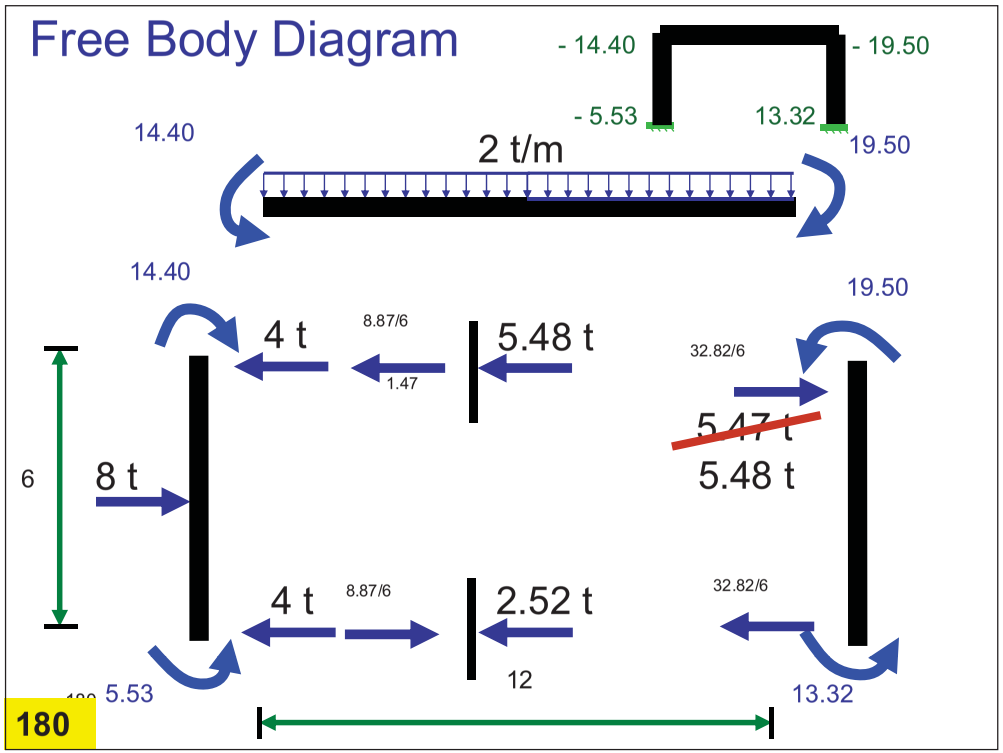
$$M_{Final} = M_o + 0.726\ M_1$$

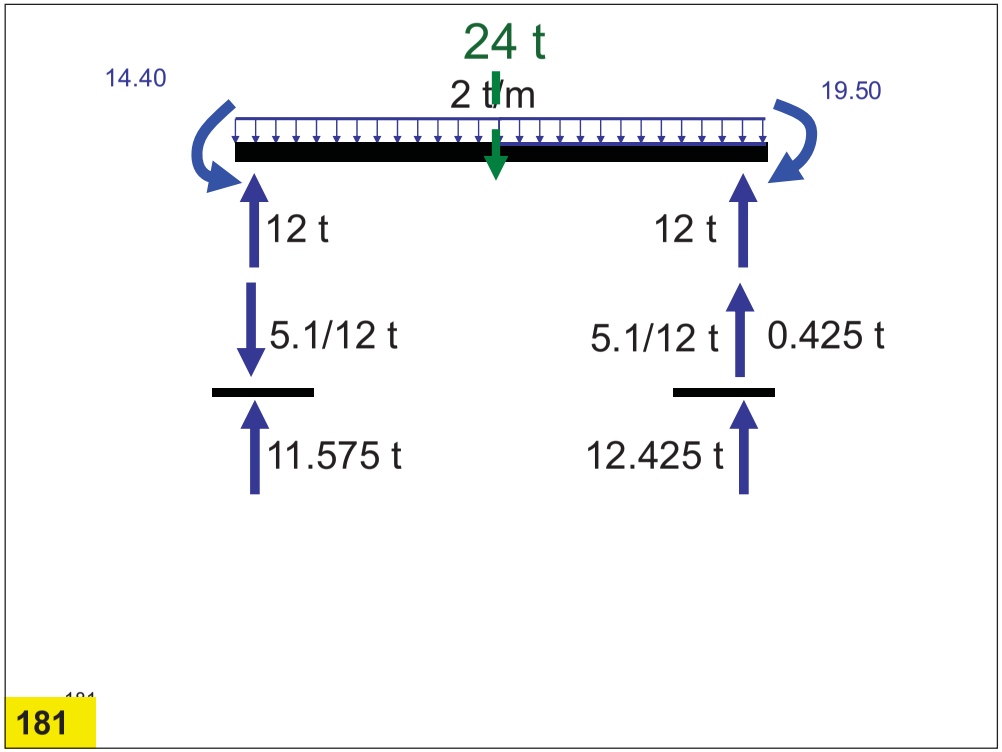
176


M_{Final}= M_o+ 0.726 M_1
-18.76+.726x6
- 14.40
- 19.50
-15.14+.726x-6
+7.51+.726x+8
13.32
+.28+.726x-8
-5.53
18.76
15.14
0.28
7.51
M_o
6
8
M_1
177

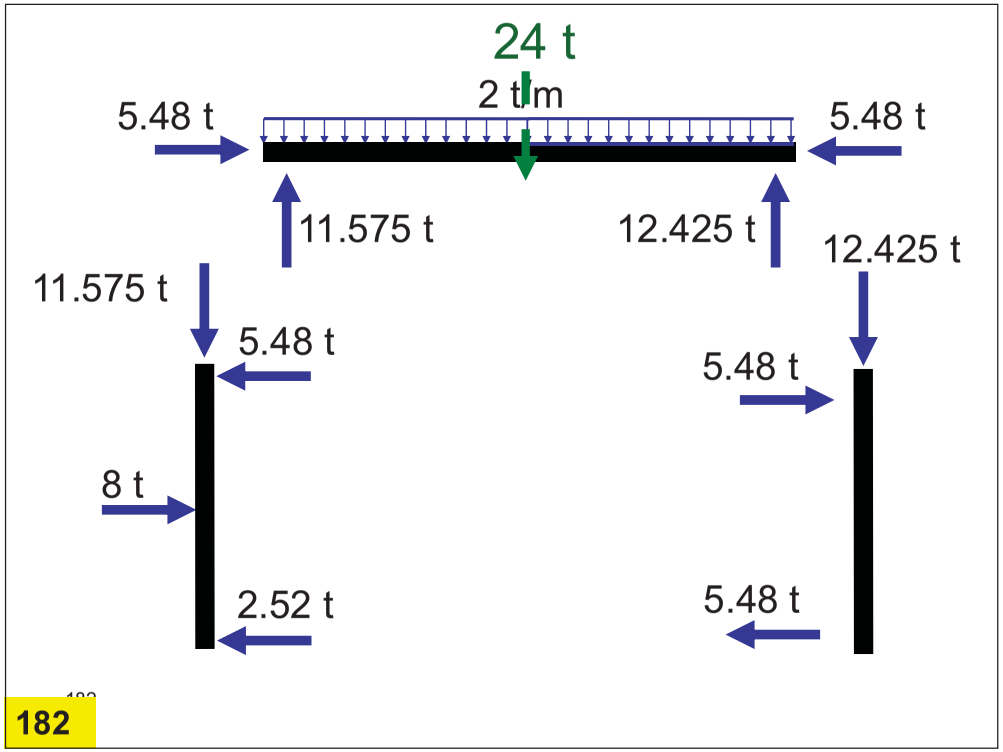

- 14.40
- 19.50
- 5.53
13.32
14.40
19.50
5.53
178


16.95
19.50
14.40
36
19.50
14.40
12
9.97
2.03
19.05
5.53
13.32
2 t/m
8 t
6
B
C
A
D
12
179

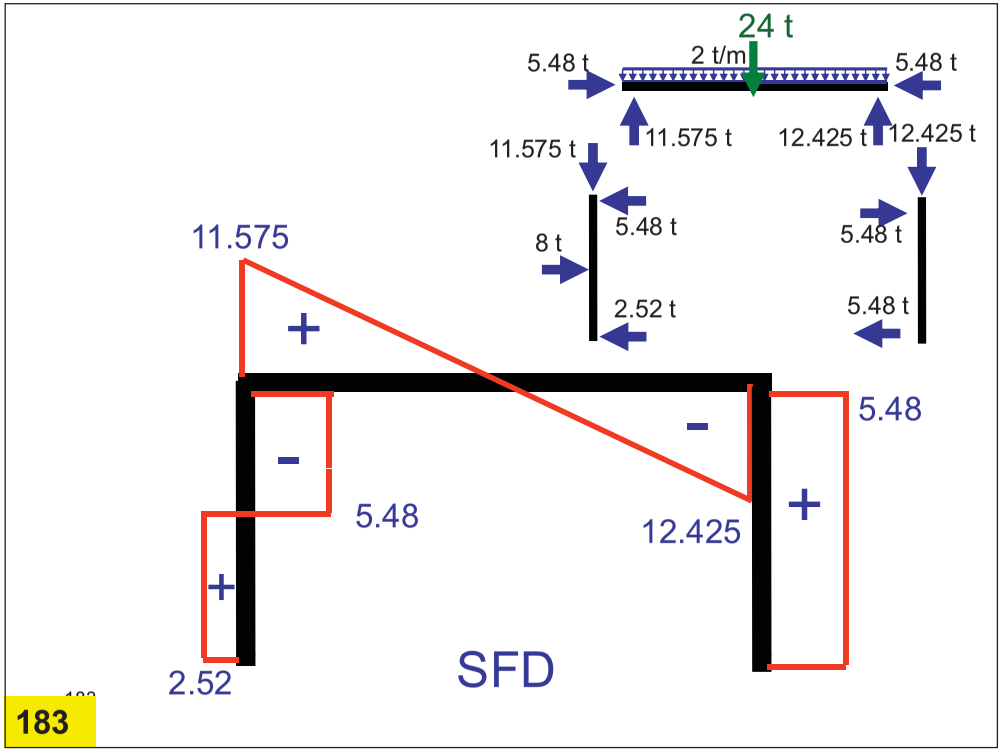

Free Body Diagram
- 14.40
- 19.50
- 5.53
13.32
14.40
2 t/m
19.50
14.40
19.50
4 t
8.87/6
5.48 t
1.47
32.82/6
5.47 t
5.48 t
6
8 t
4 t
8.87/6
2.52 t
12
32.82/6
5.53
13.32
180



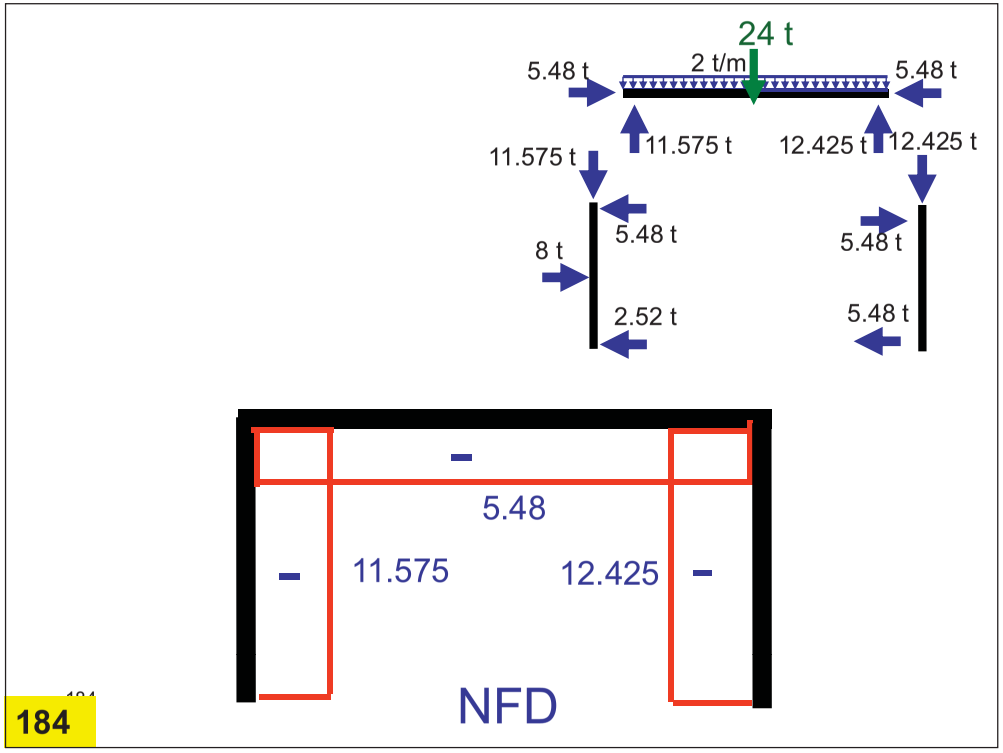
181



182



183



184

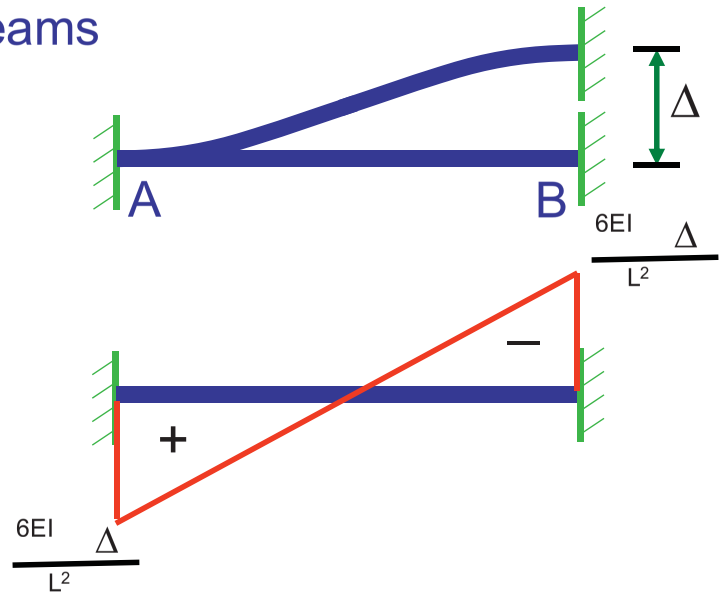
بســـم اللـــــه الرحمـــن الرحيـــم

Approximate Method

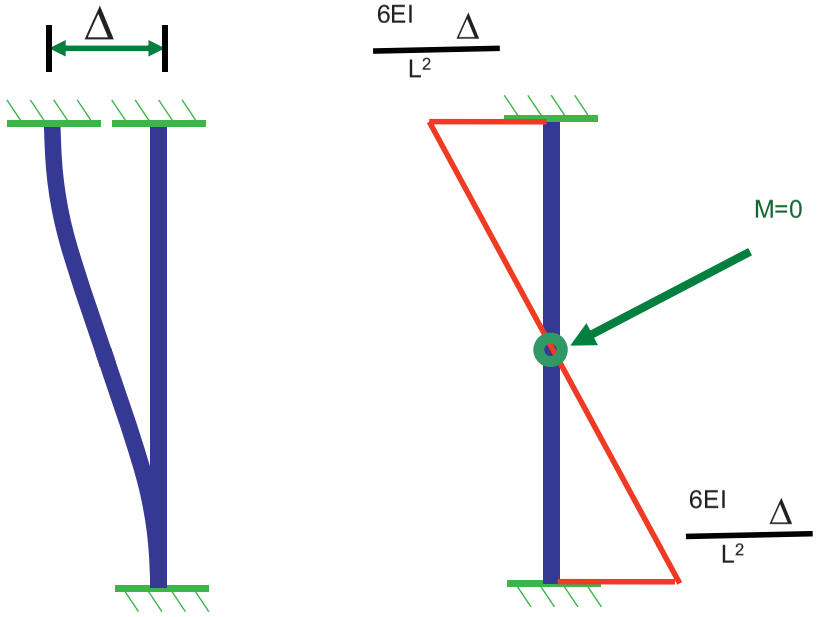
Portal Frame

Introduction :

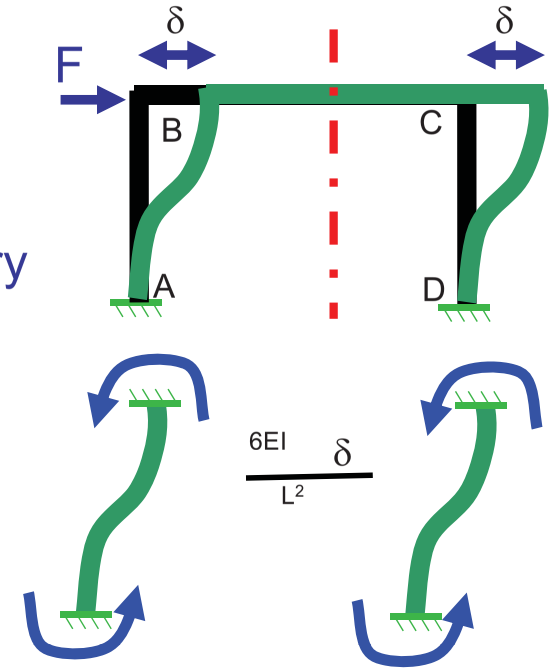
Beams

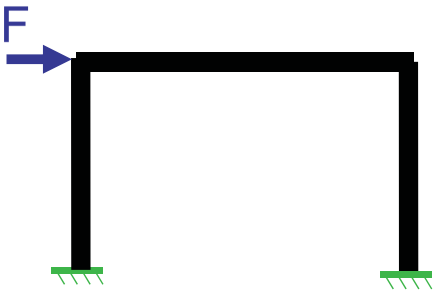


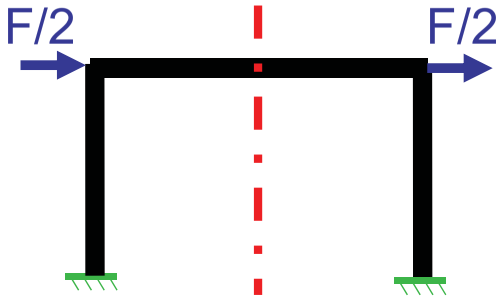
Columns



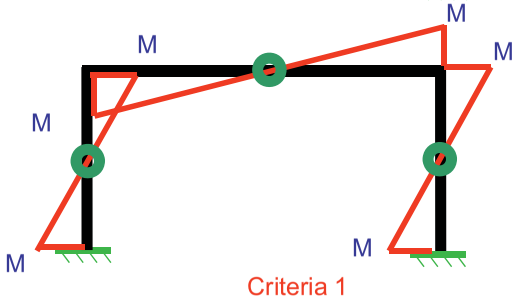
Anti-Symmetry







189

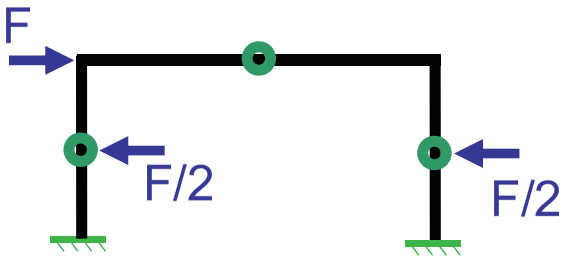


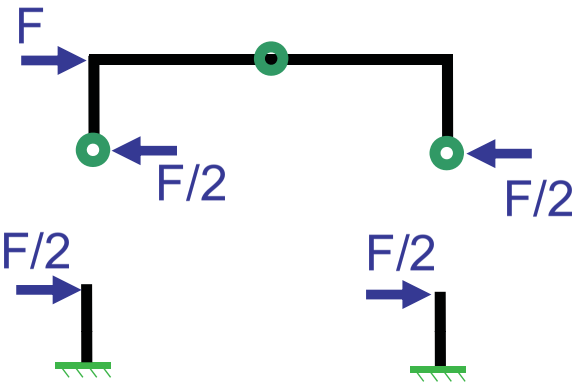
Criteria 1

When frame is subjected to lateral loads

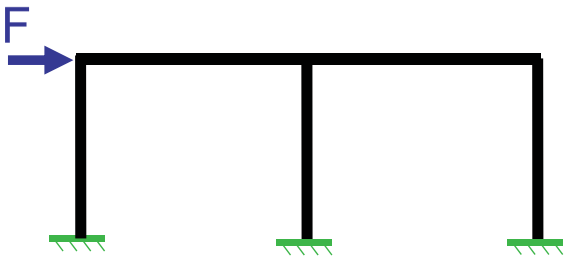
We can put intermediate hinge in the mid of each member

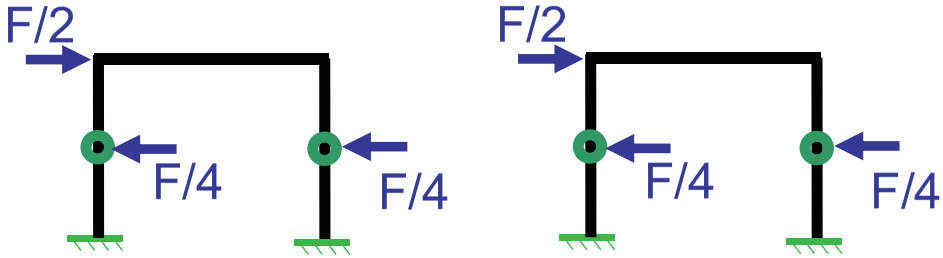
190



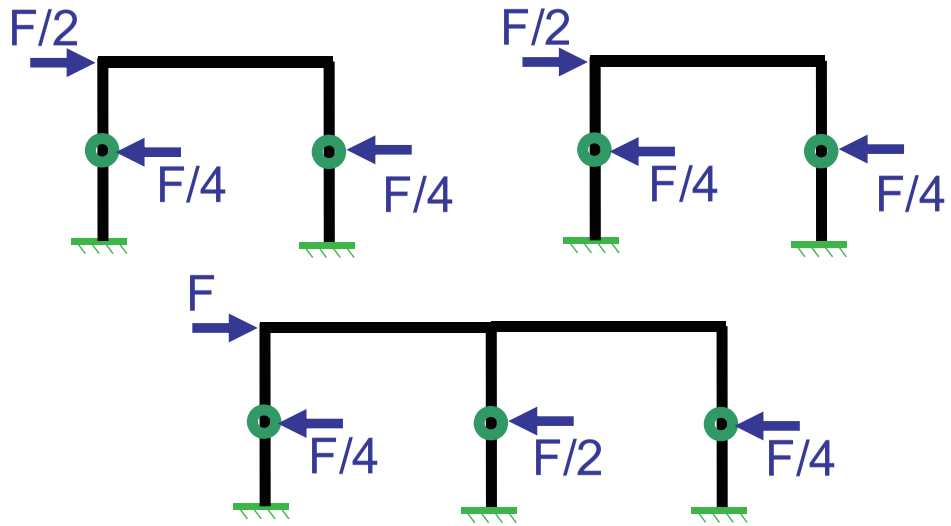


191





192



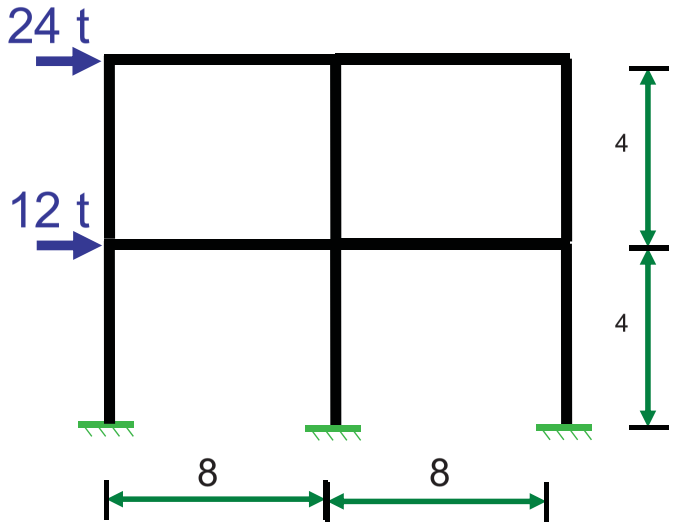
Criteria 2

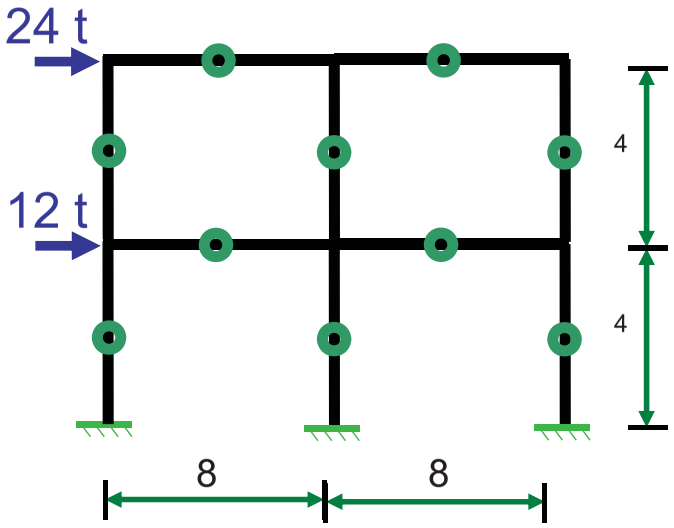
When frame is subjected to lateral loads

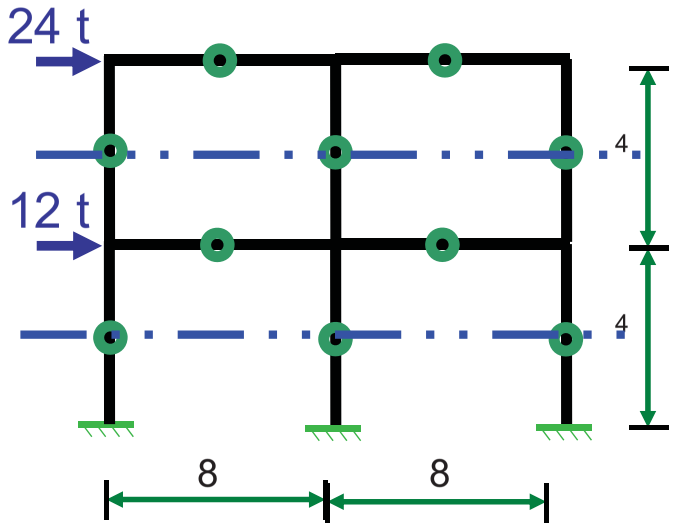
the interior column carries the double of the exterior column

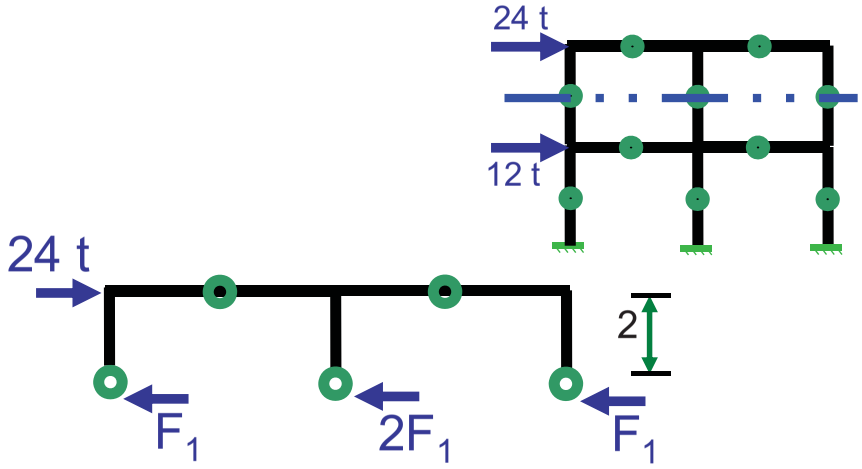
Example 1 :

Draw B.M, S.F & N.F.D^{s} for the shown frame







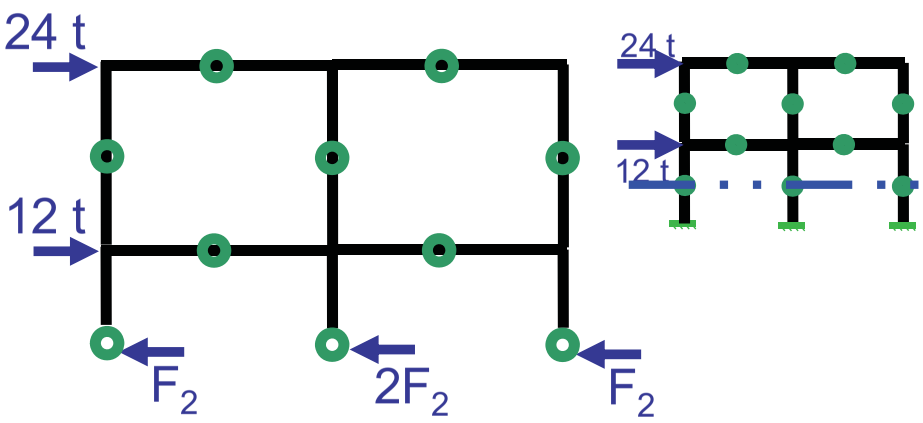


$$\Sigma F_x = 0$$

$$4 F_1 = 24$$

$$F_1 = 6$$

197

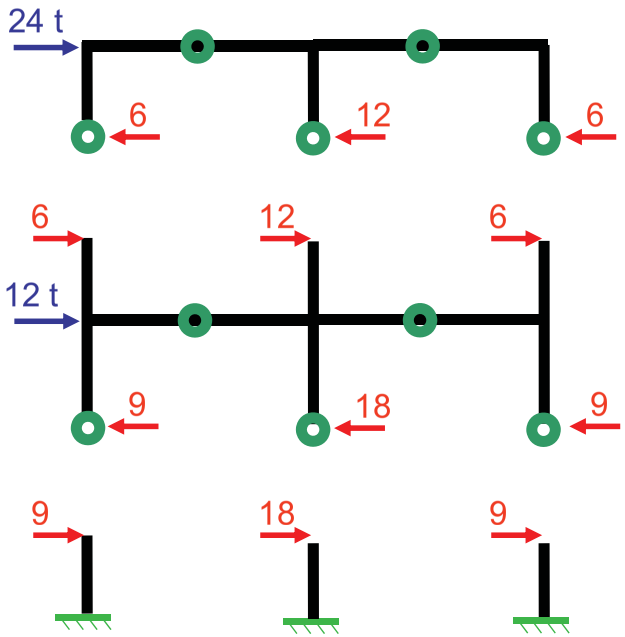


$$\Sigma F_x = 0$$

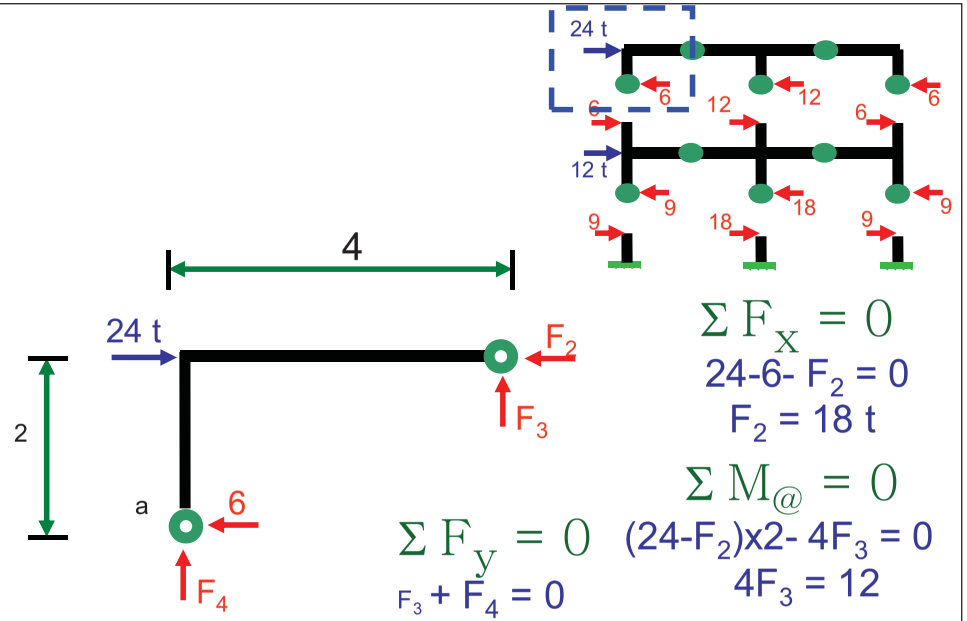
$$4 F_2 = 36$$

$$F_2 = 9$$

198



199



$$\Sigma F_x = 0$$

$$24\text{-}6\text{-}F_2 = 0$$

$$F_2 = 18 \text{ t}$$

$$\Sigma M_{@} = 0$$

$$(24\text{-}F_2)x2\text{-}4F_3 = 0$$

$$4F_3 = 12$$

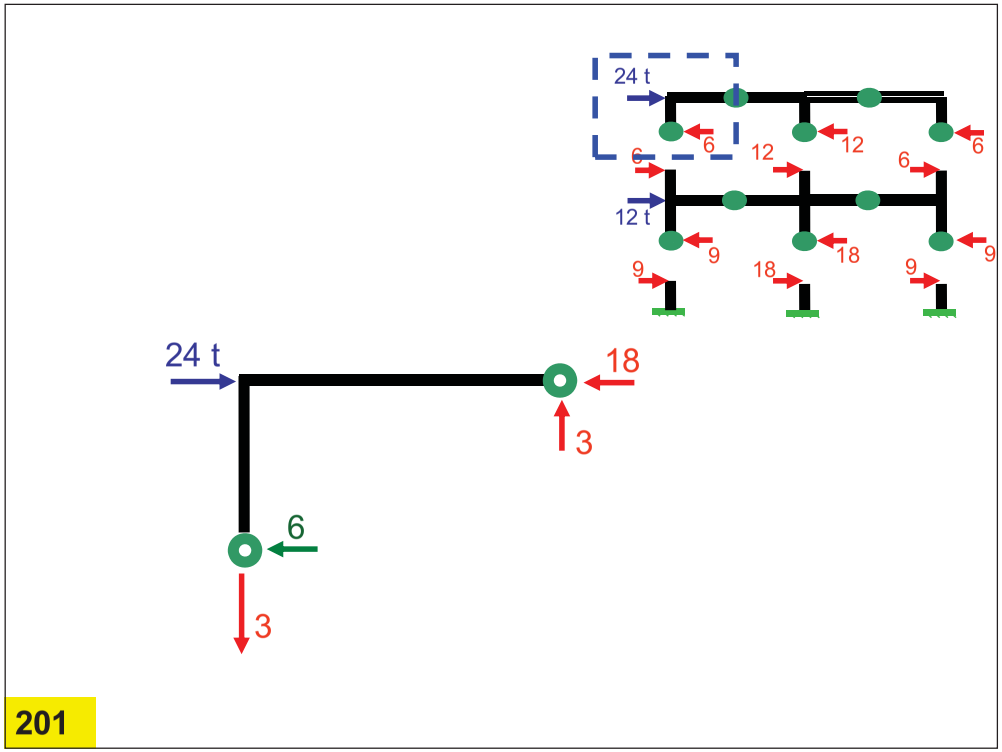
$$F_3 = 3$$

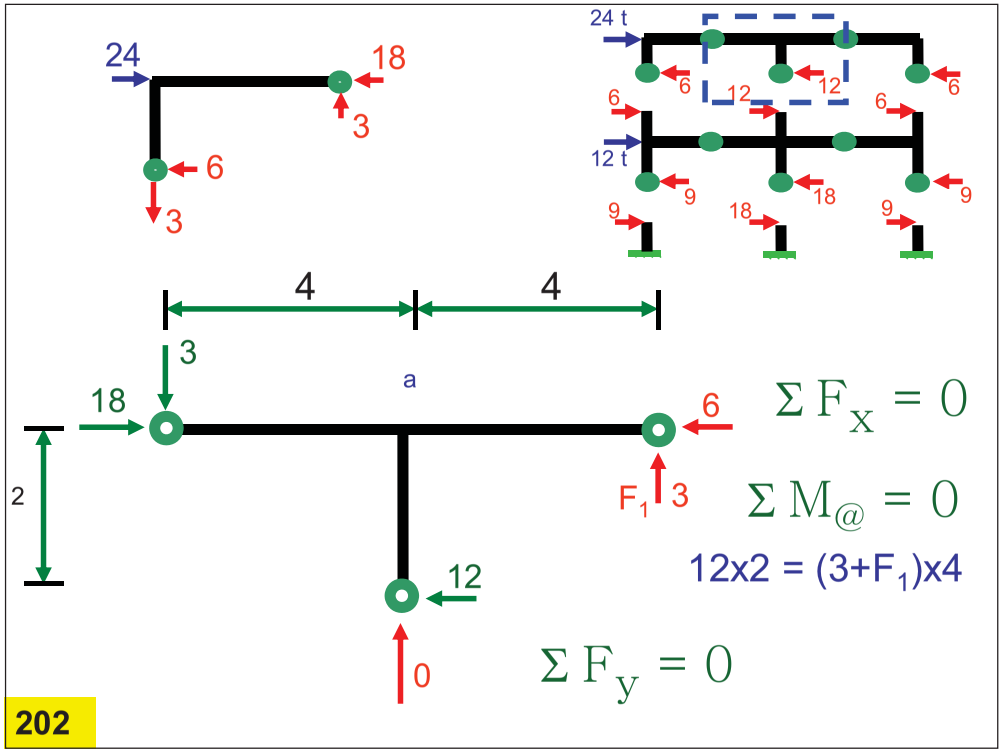
$$\Sigma F_y = 0$$

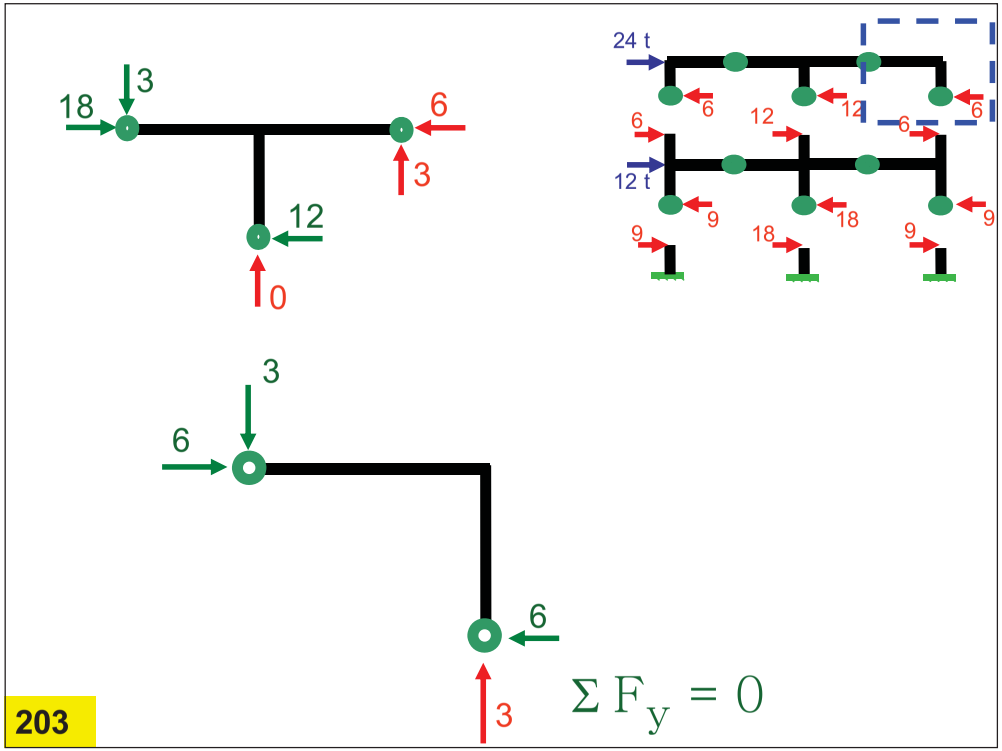
$$F_3 + F_4 = 0$$

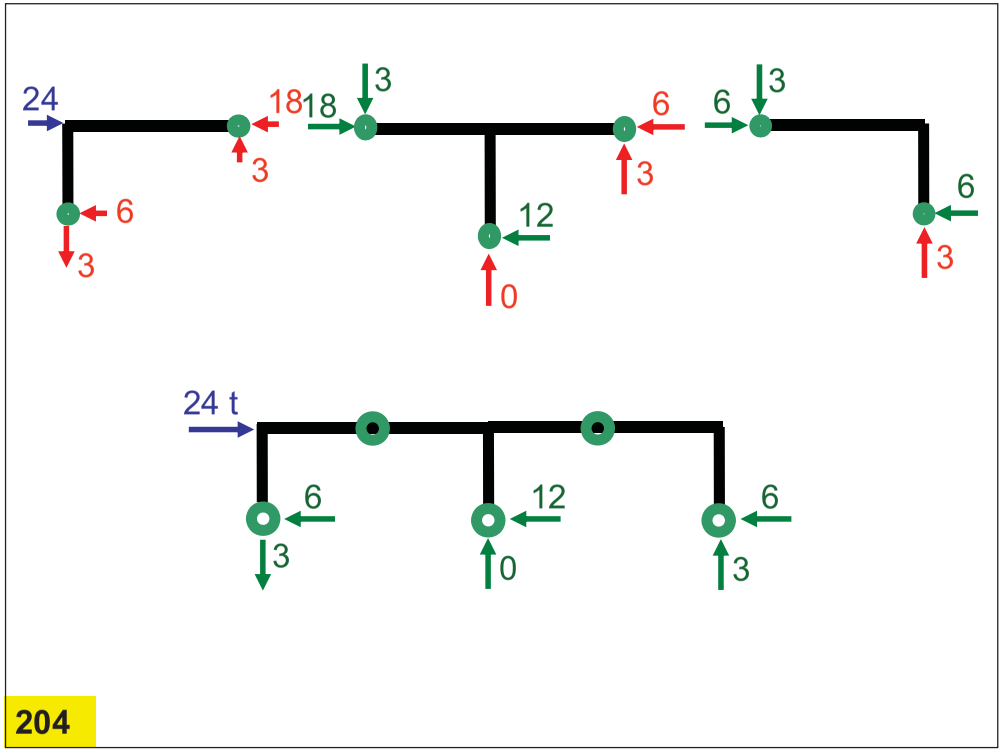
$$F_4 = -3$$

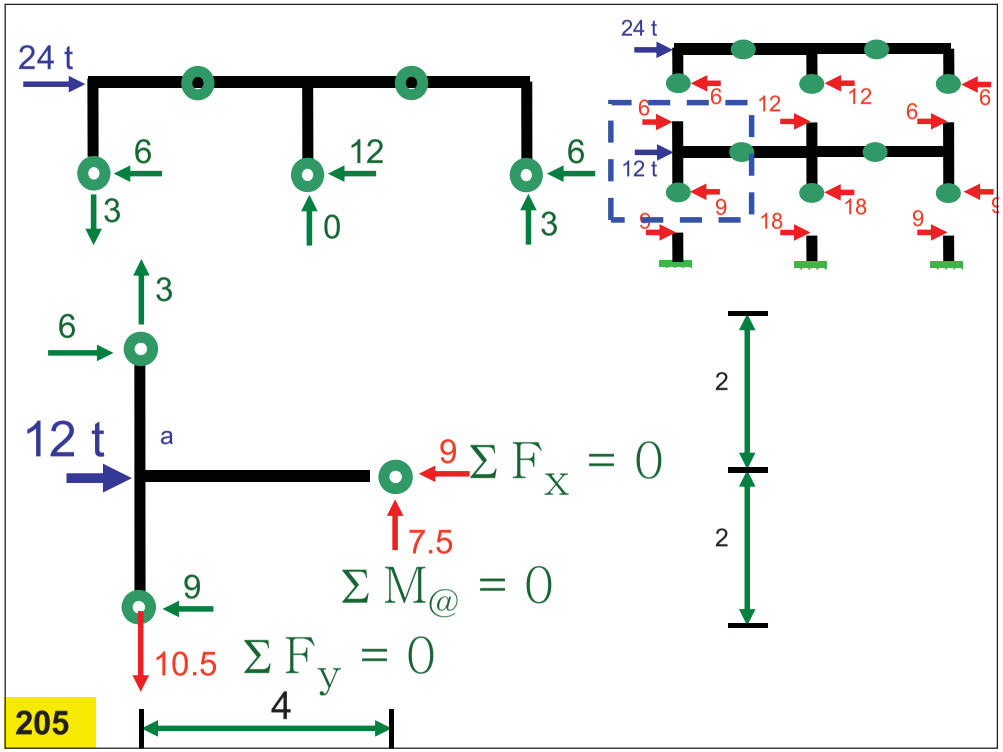
200

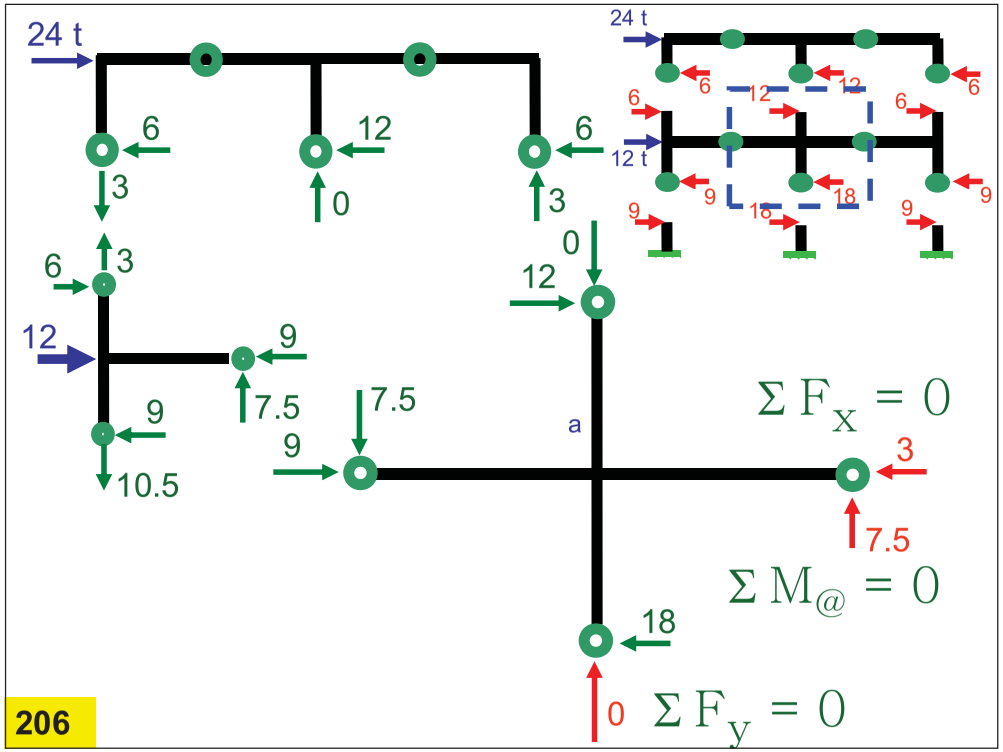

24 t
18
3
6
3
24 t
6
12
12
6
12 t
9
18
18
9
9
201

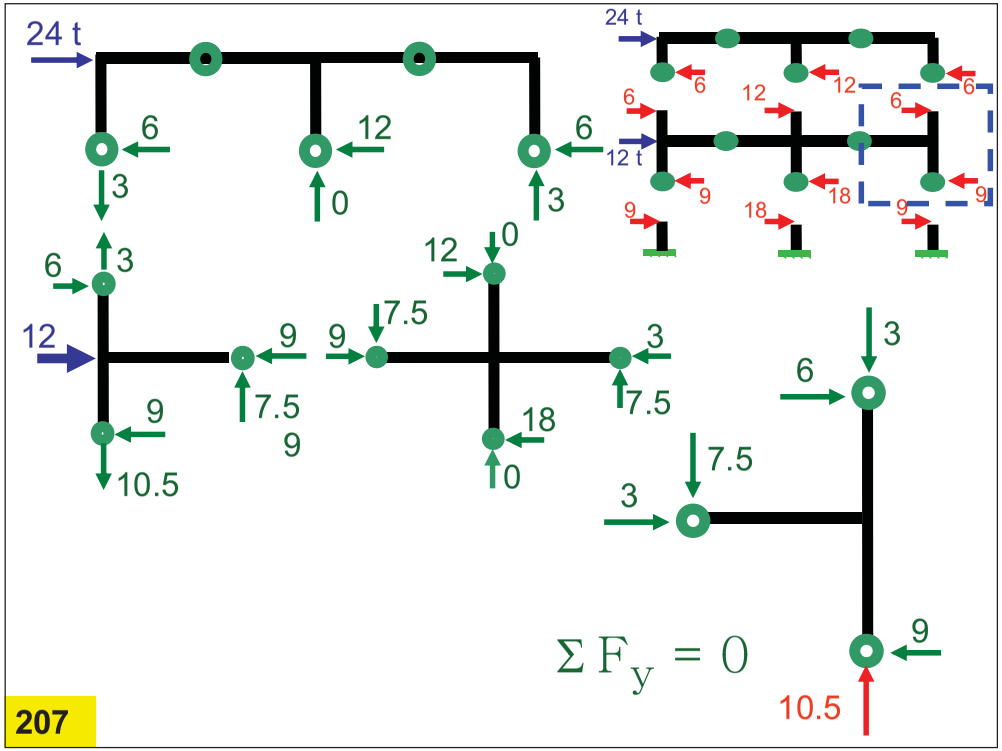

24
18
3
6
3
24 t
6
12
12
6
12 t
9
18
18
9
9
4
4
3
a
18
6
2
F1
3
12
0
ΣFx = 0
ΣM@ = 0
12x2 = (3+F1)x4
ΣFy = 0
202

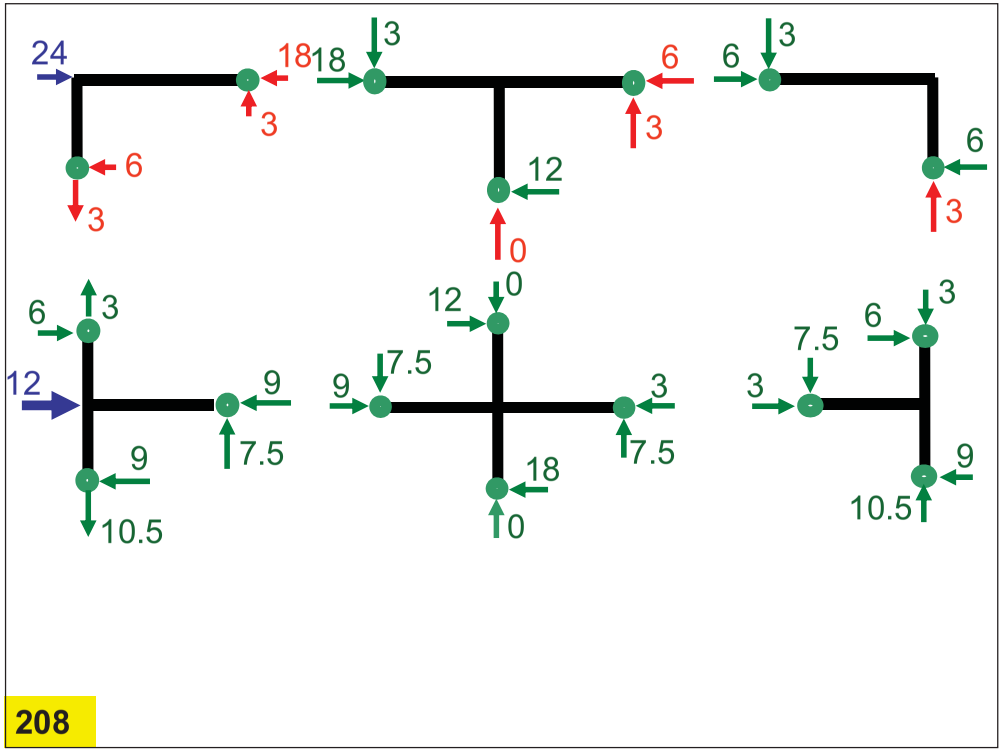

18
3
6
3
12
0
24 t
6
12
12
6
12 t
9
18
18
9
9
3
6
6
3
ΣFy = 0
203

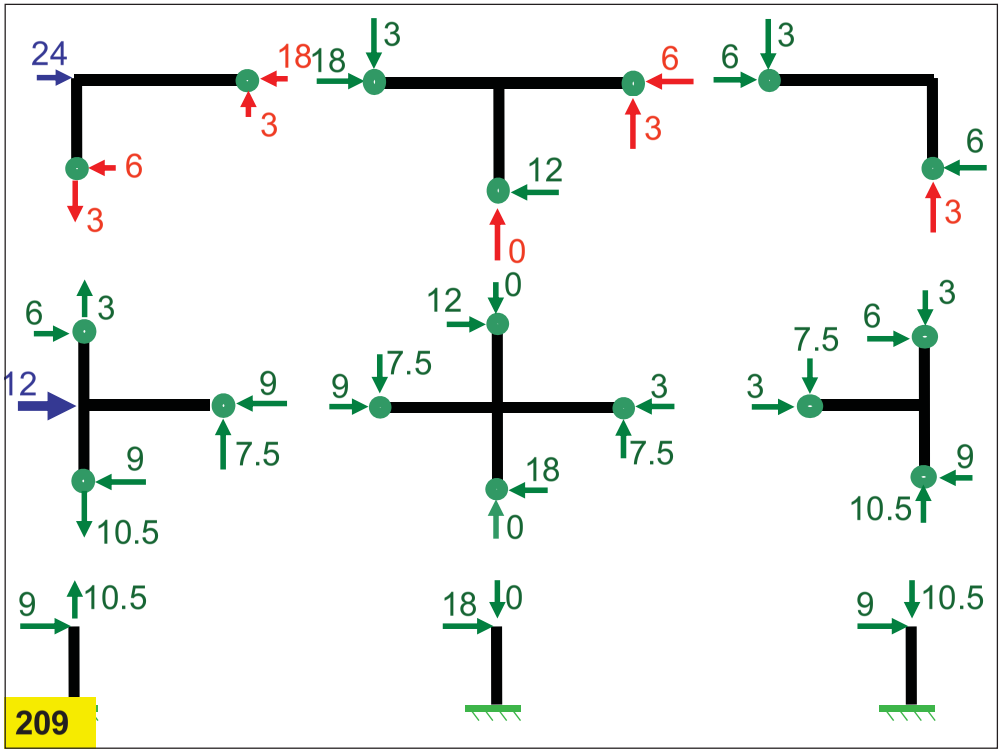

24
18
3
6
3
18
3
6
3
12
0
6
3
6
3
24 t
6
12
6
3
0
3
204

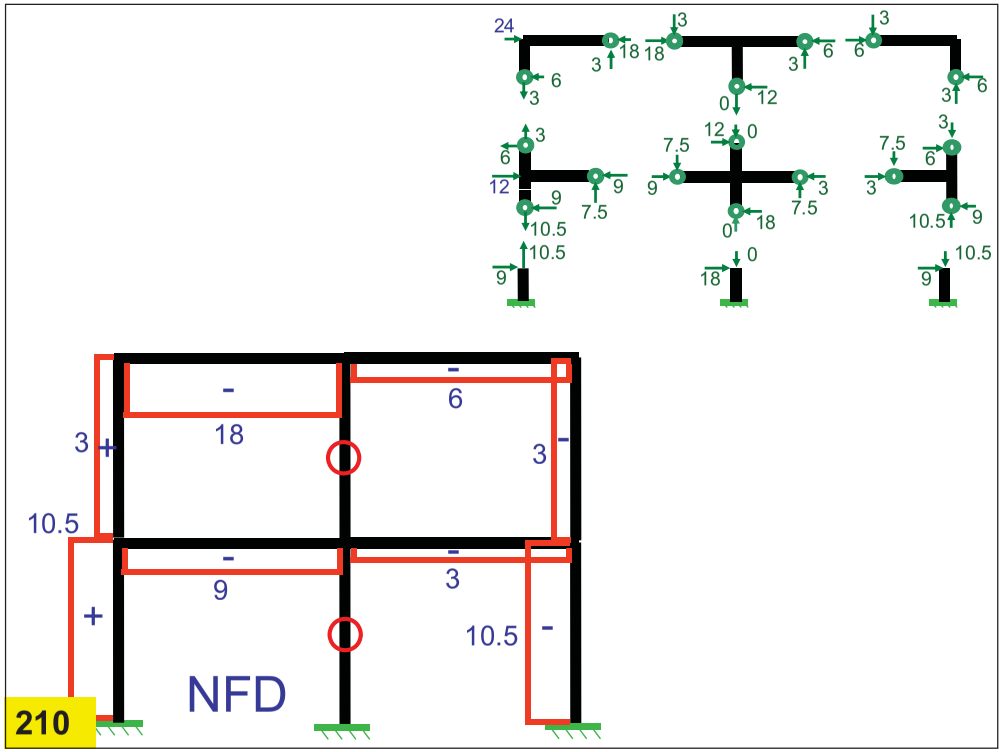

24 t
6
12
6
3
0
3
24 t
6
12
12
6
6
12 t
12
9
18
18
9
9
3
6
12 t
a
9
$\Sigma F_x = 0$
7.5
$\Sigma M_@ = 0$
9
10.5
$\Sigma F_y = 0$
2
2
4
205

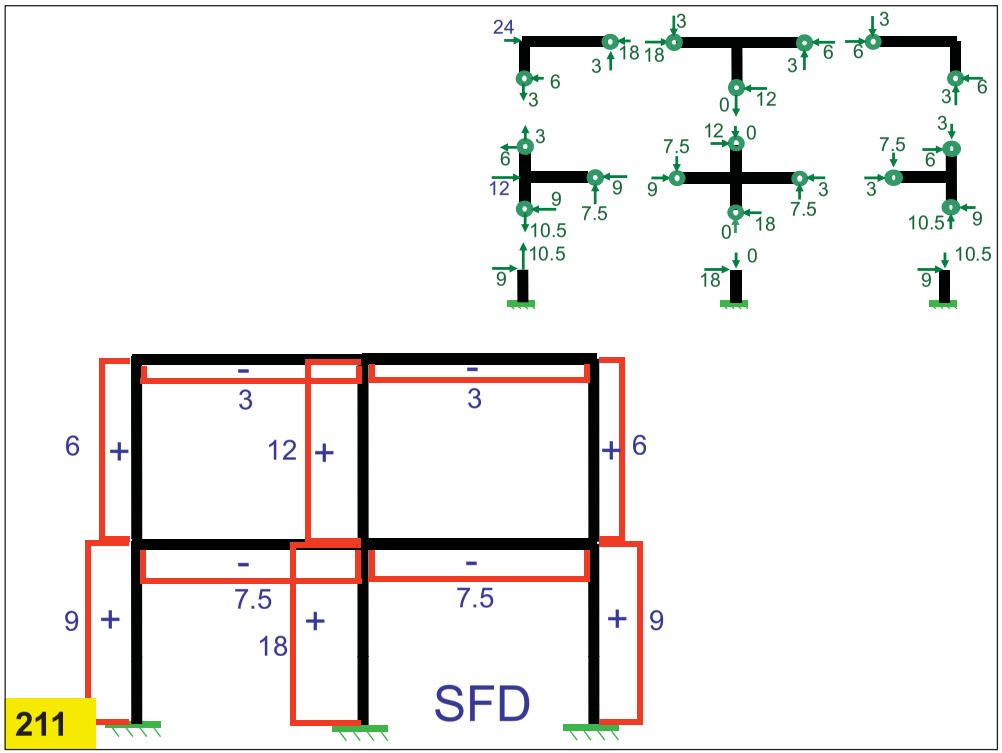

24 t
6
12
6
3
0
3
24 t
6
12
12
6
6
12 t
12
9
18
18
9
9
6
3
12
9
7.5
9
10.5
0
12
a
7.5
$\Sigma F_x = 0$
3
7.5
$\Sigma M_@ = 0$
18
0
$\Sigma F_y = 0$
206

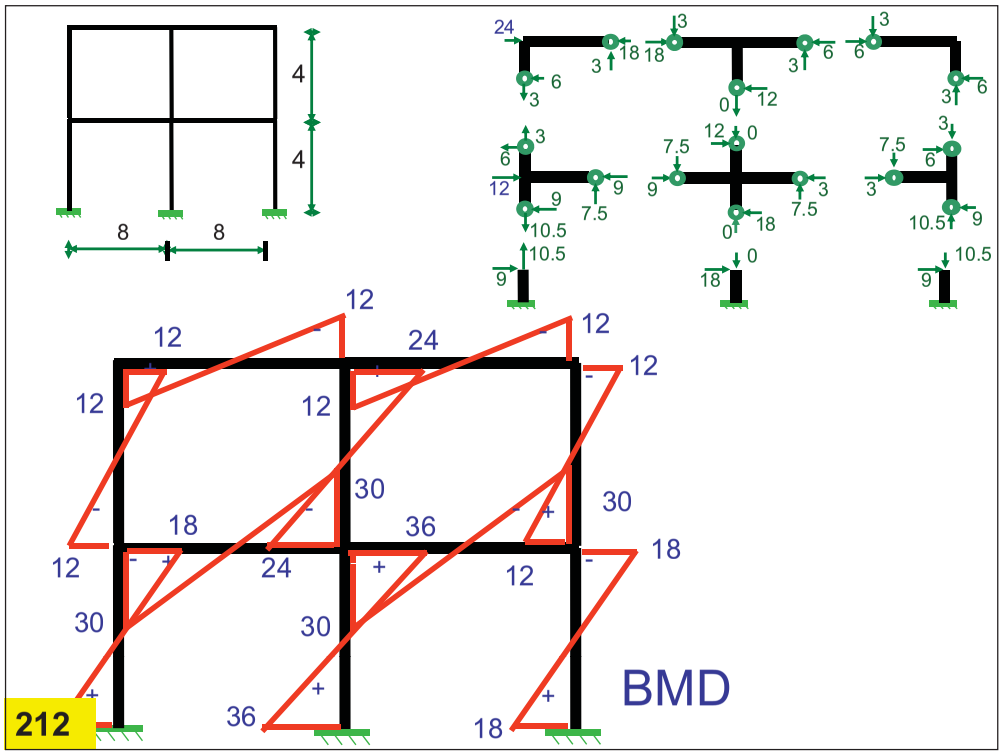

24 t
6
12
6
3
0
3
24 t
6
12
12
6
6
12 t
12
9
18
18
9
9
6
3
12
9
7.5
9
10.5
12
0
9
7.5
9
3
7.5
18
0
6
3
7.5
3
$\Sigma F_y = 0$
9
10.5
207


24
18
3
6
3
18
3
6
3
6
3
12
0
6
3
12
9
7.5
9
10.5
12
0
7.5
9
3
7.5
18
0
6
3
7.5
3
9
10.5
208


209

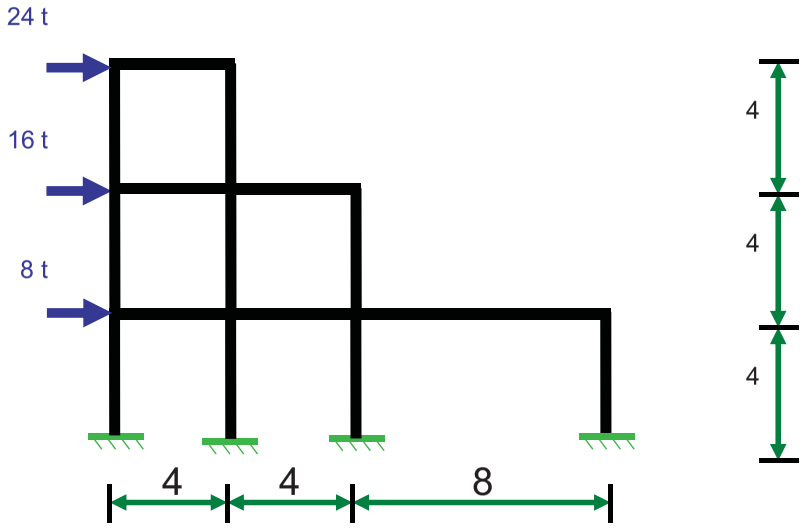

NFD
210

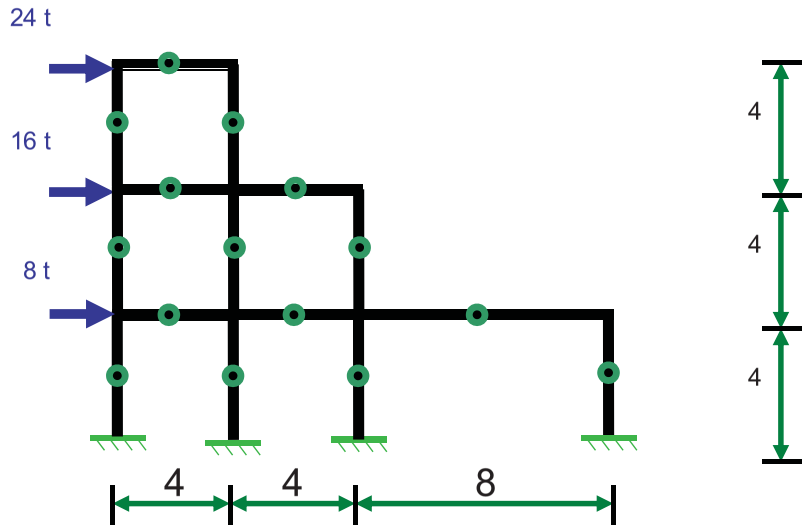

SFD
211

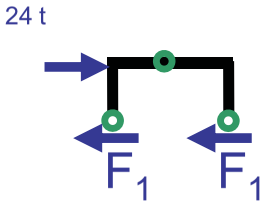

BMD
212

Example 2 :

Draw B.M, S.F & N.F.D^{s} for the shown frame



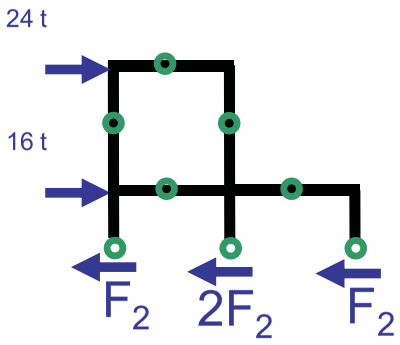




$$\Sigma F_x = 0$$

$$2 F_1 = 24$$

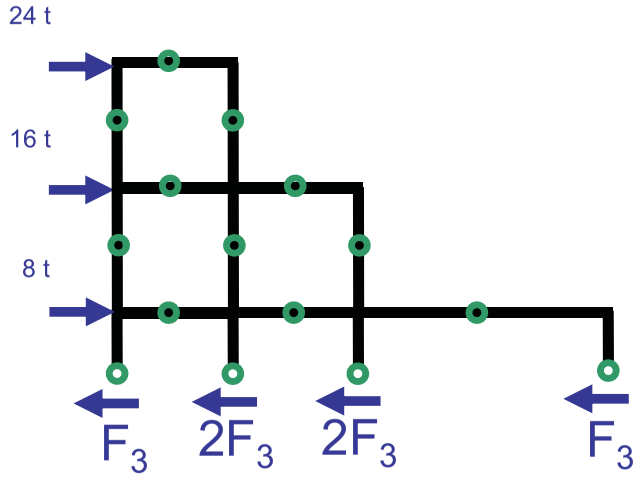
$$\boxed{F_1 = 12}$$



$$\Sigma F_x = 0$$

$$4 F_2 = 40$$

$$\boxed{F_2 = 10}$$

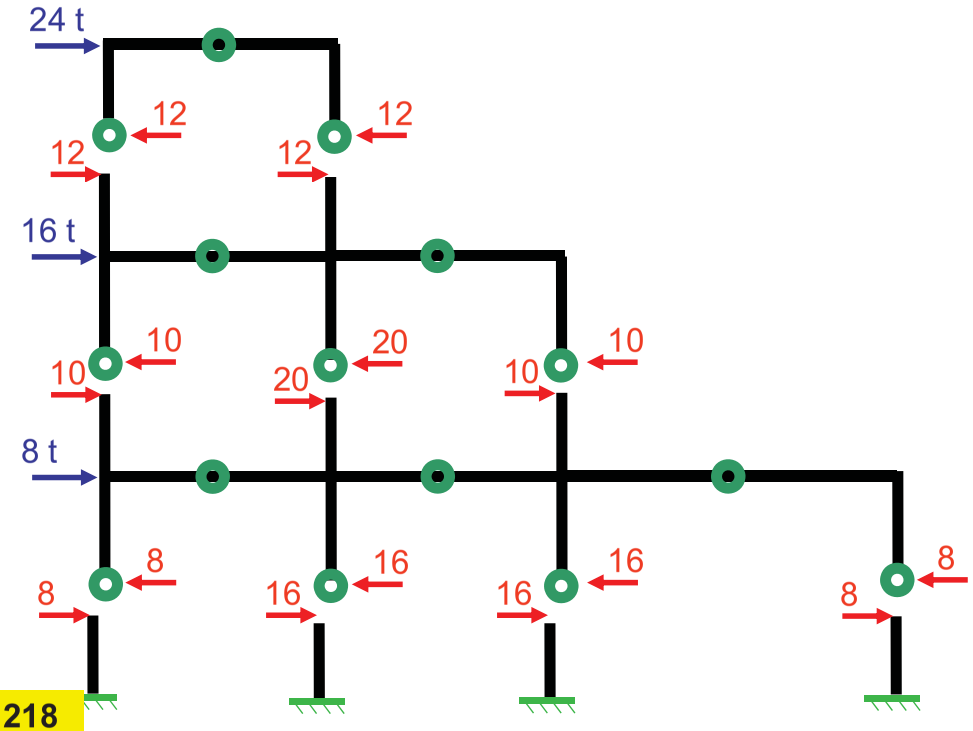


$$\Sigma F_x = 0$$

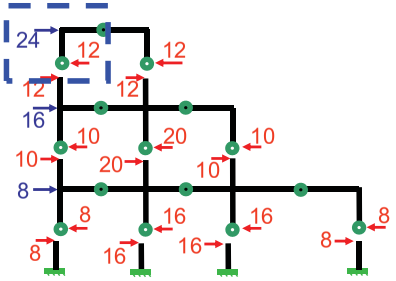
$$6\,F_3 = 48$$

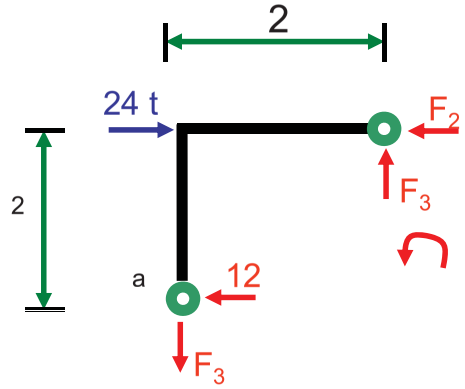
$$\boxed{F_3 = 8}$$

217



218





$$\Sigma F_x = 0$$

$$24\text{-}12\text{-}F_2 = 0$$

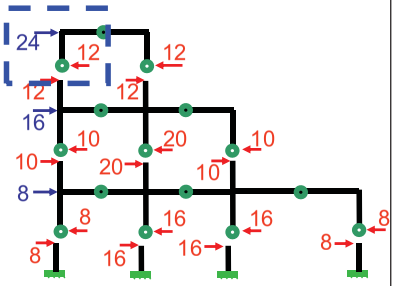
$$F_2 = 12\ t$$

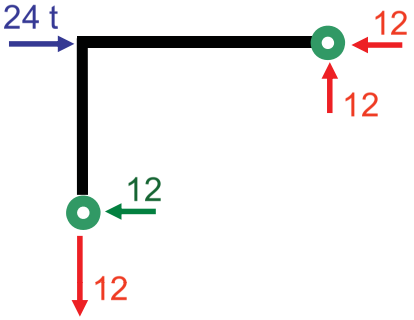
$$M_{reaction} = M_{action}$$

$$2\,F_3 = 12 \times 2$$

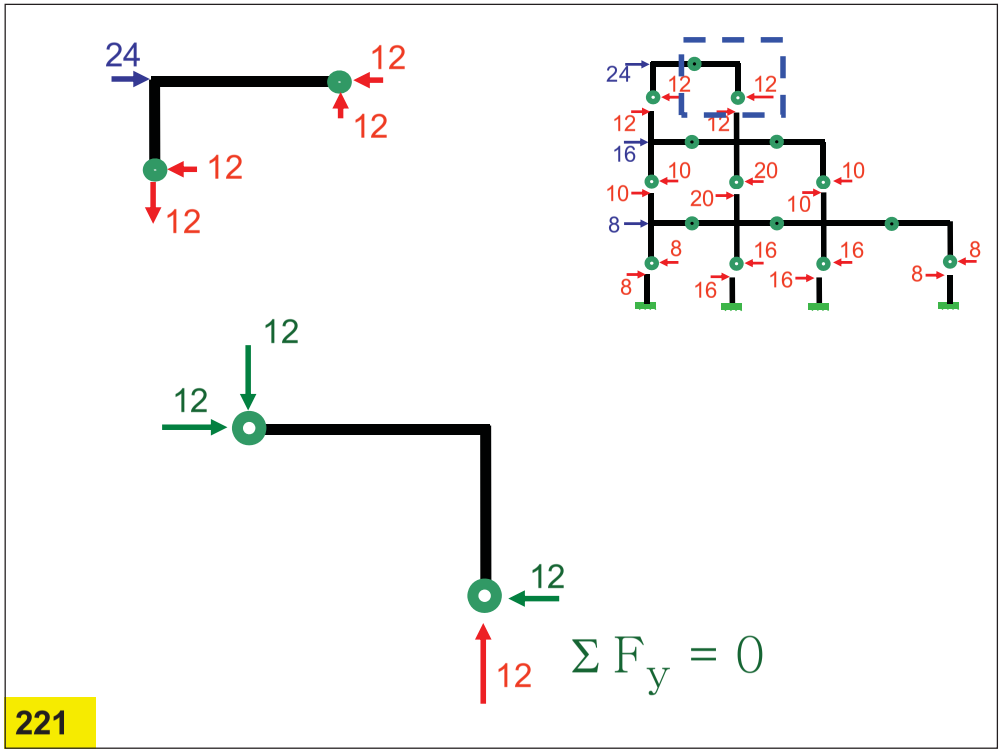
$$F_3 = 12$$

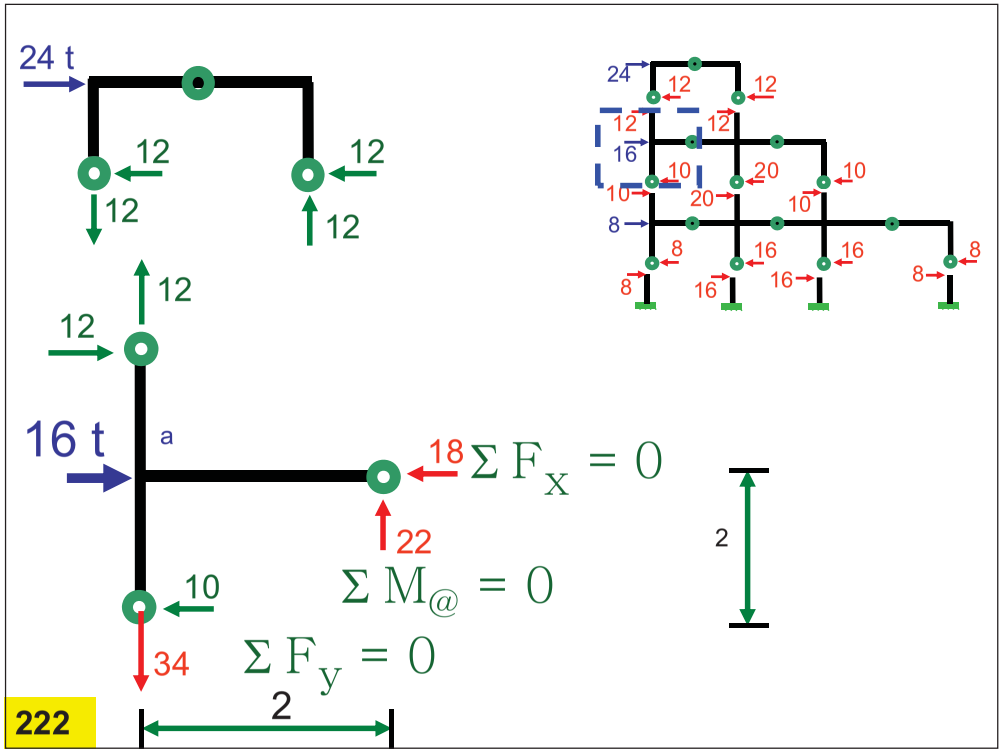
219

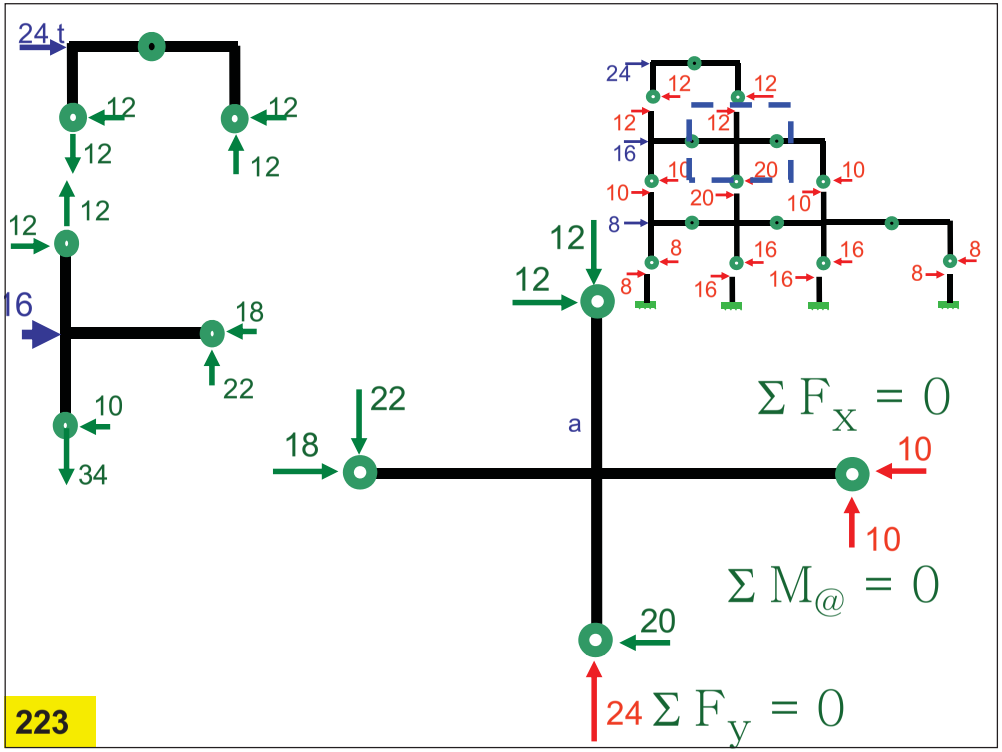


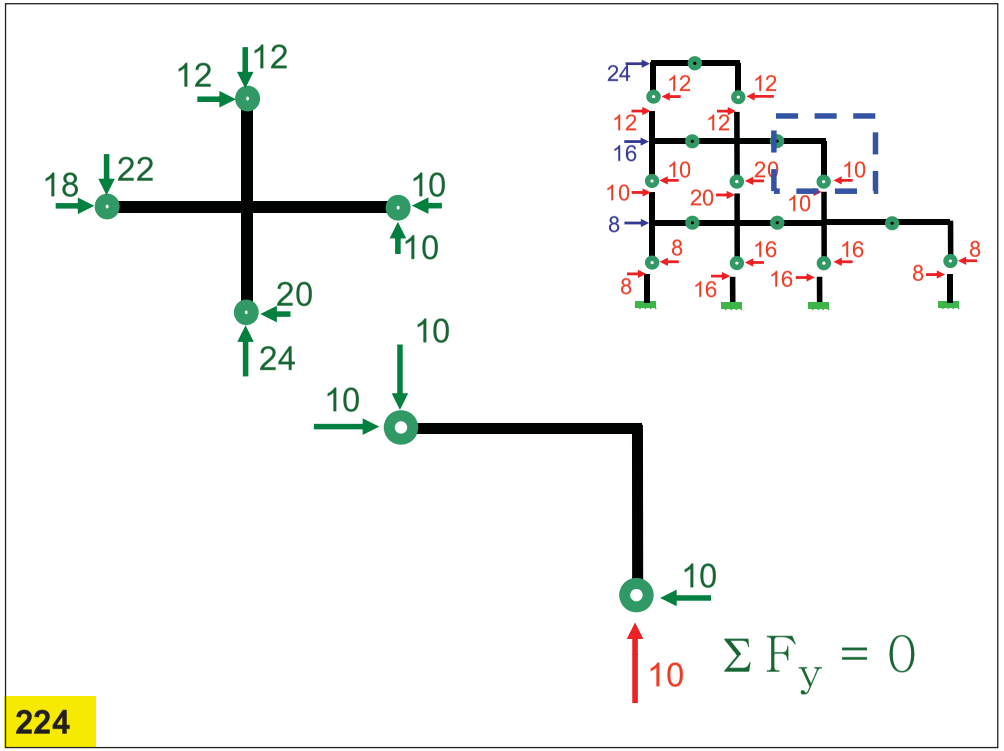


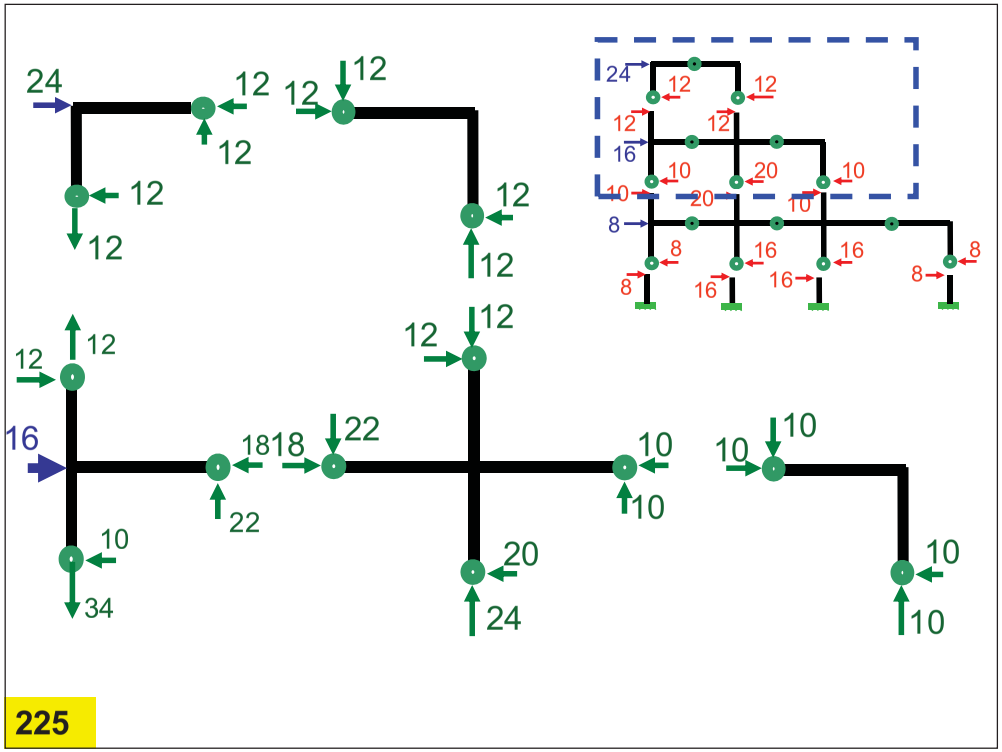
220

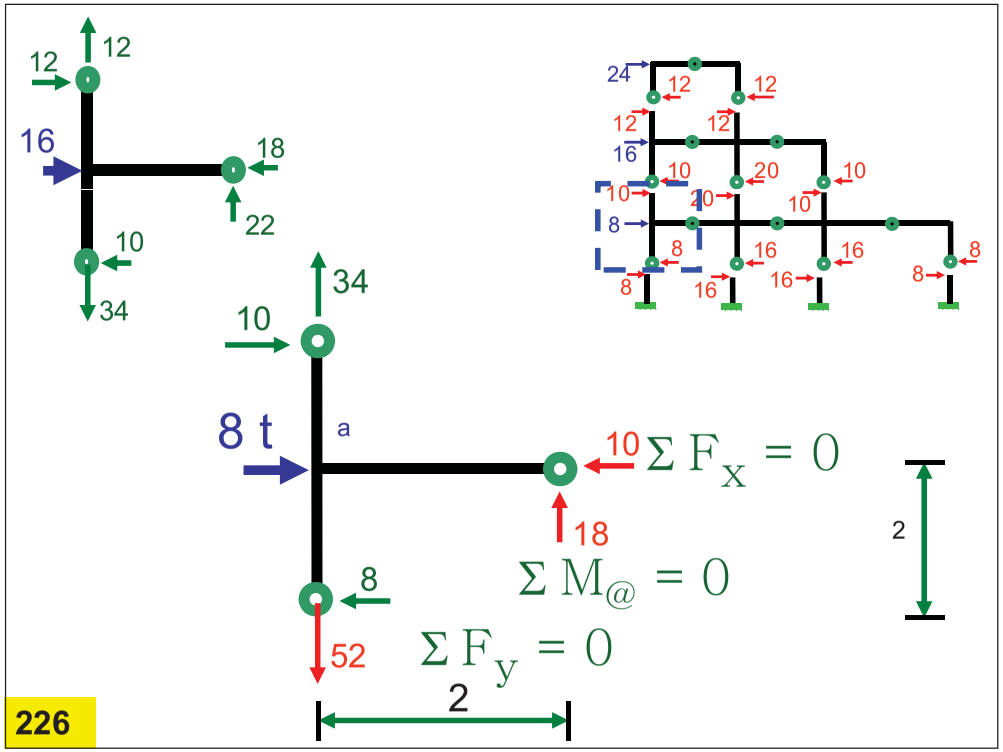

24
12
12
12
12
12
12
12
12
12
$\Sigma F_y = 0$
221

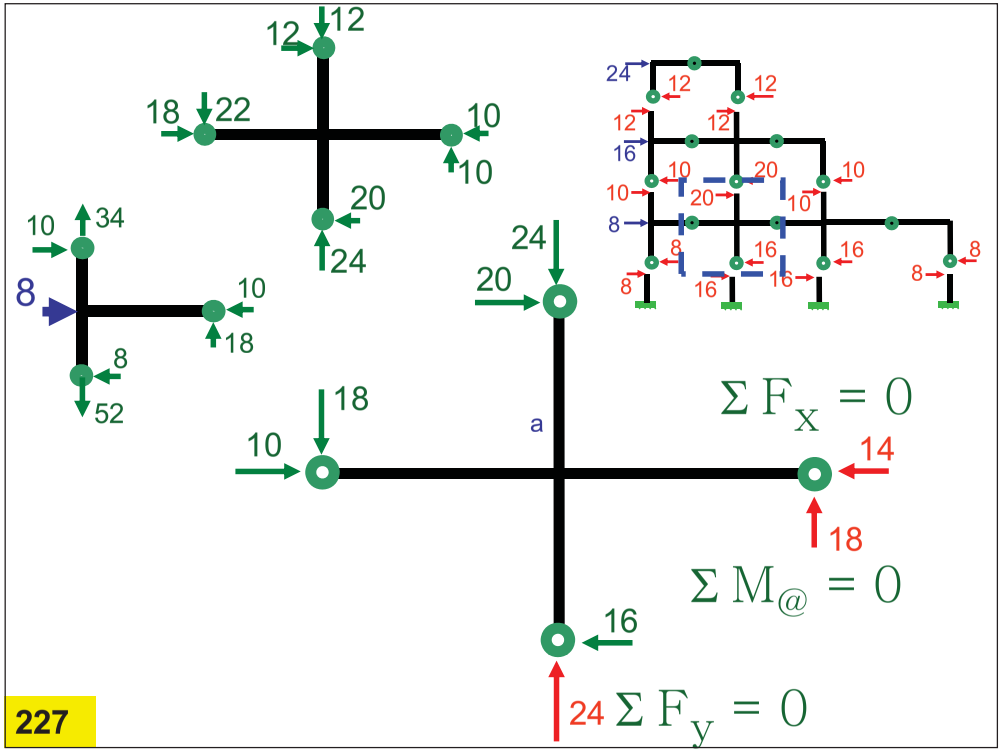

24 t
12
12
12
12
12
16 t
a
18
$\Sigma F_x = 0$
22
$\Sigma M_@ = 0$
10
34
$\Sigma F_y = 0$
2
2
222

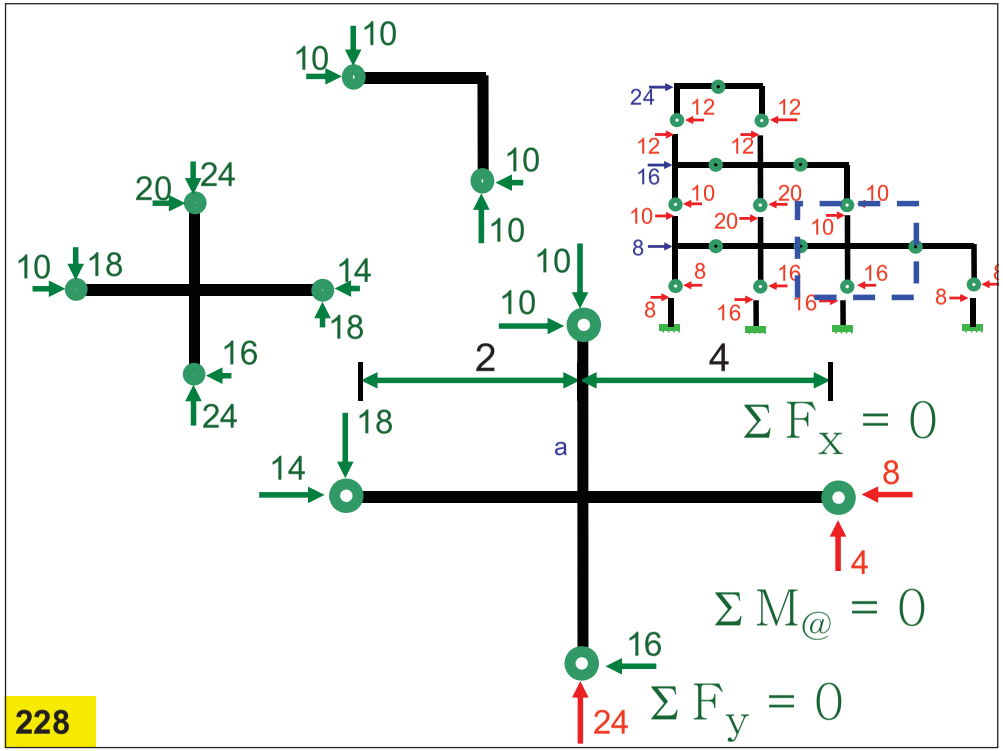

24 t
12
12
12
12
12
16
18
22
10
34
12
12
a
18
22
10
10
20
24
$\Sigma F_x = 0$
$\Sigma M_@ = 0$
$\Sigma F_y = 0$
223

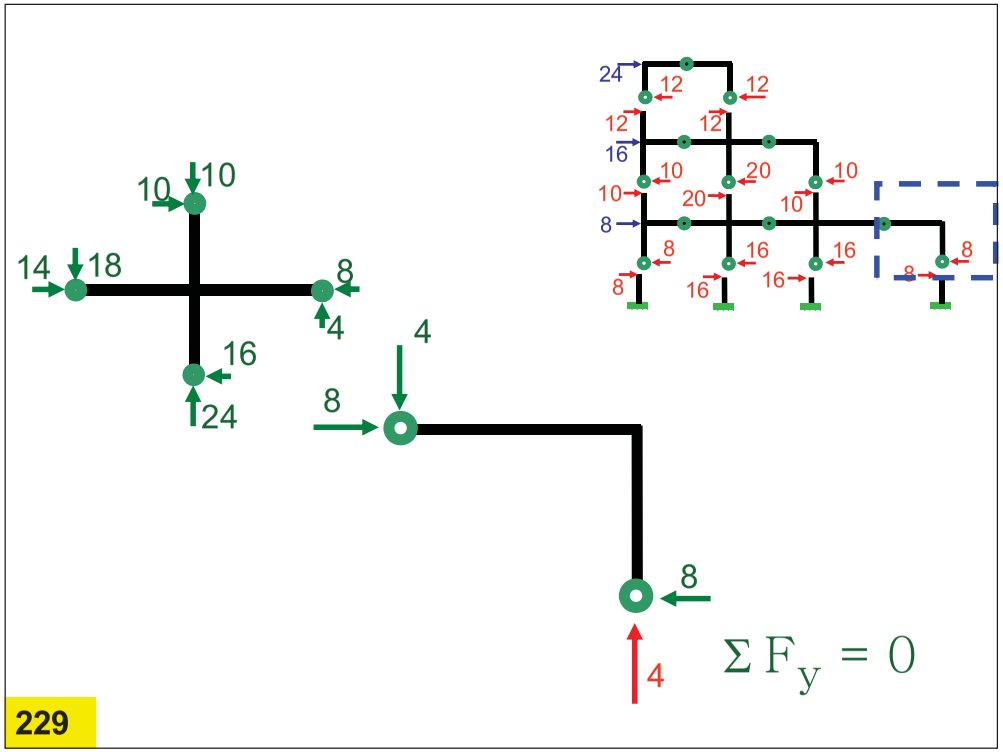

12
12
18
22
10
10
20
24
10
10
10
$\Sigma F_y = 0$
224


225

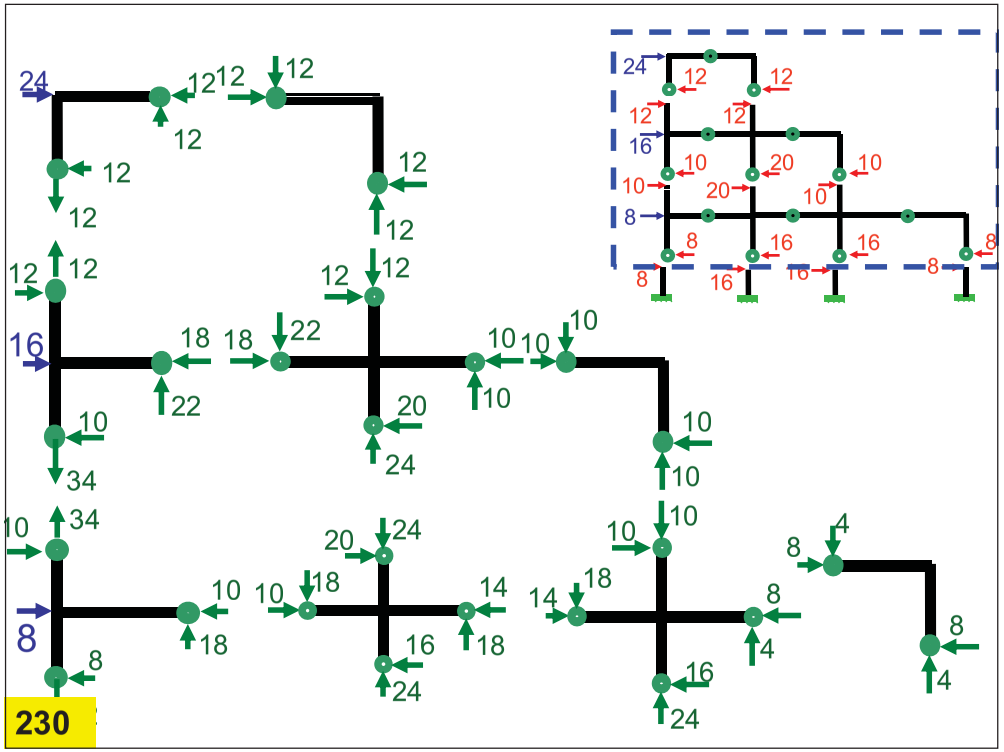

8 t
a
ΣFx = 0
ΣM@ = 0
ΣFy = 0
2
226


a
ΣFx = 0
ΣM@ = 0
ΣFy = 0
227

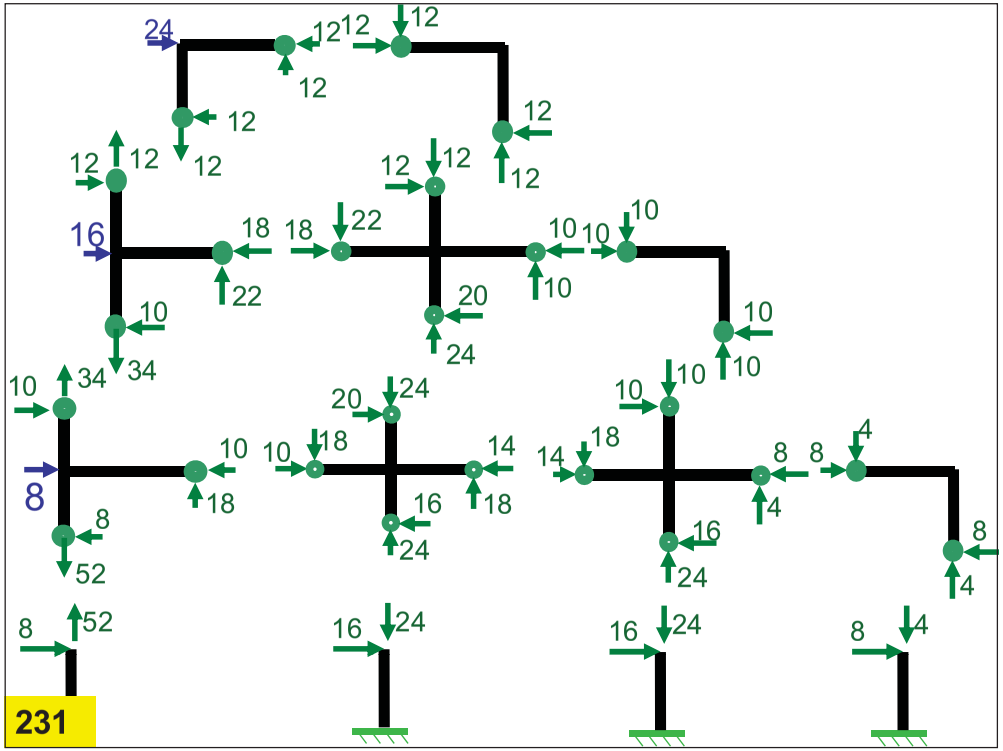

a
2
4
ΣFx = 0
ΣM@ = 0
ΣFy = 0
228



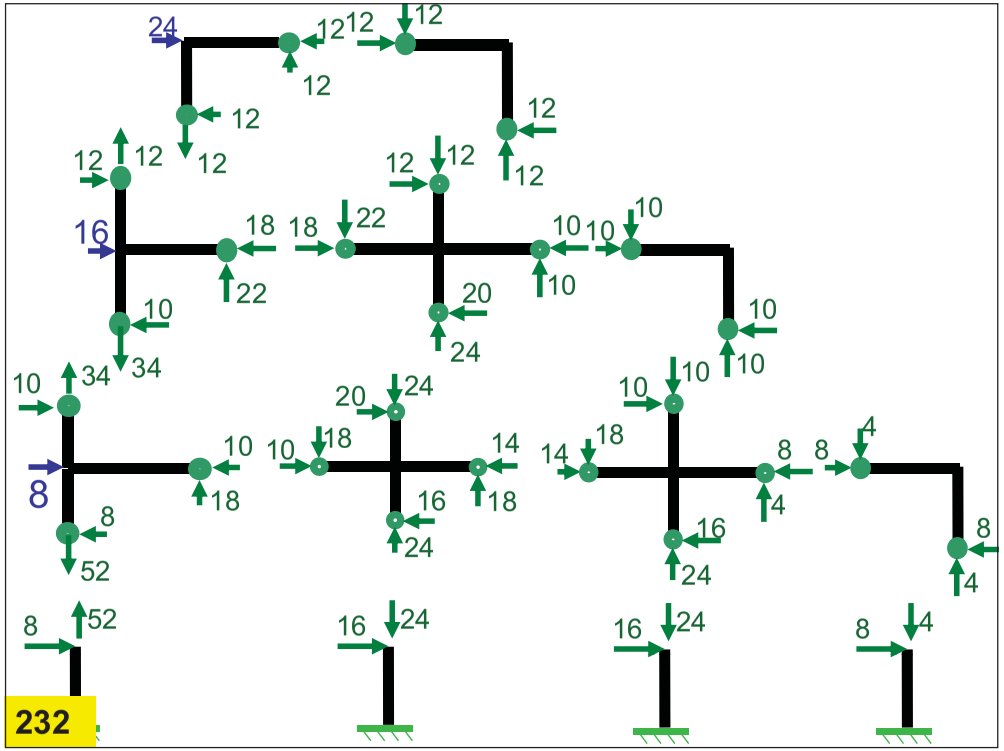
229



230



231

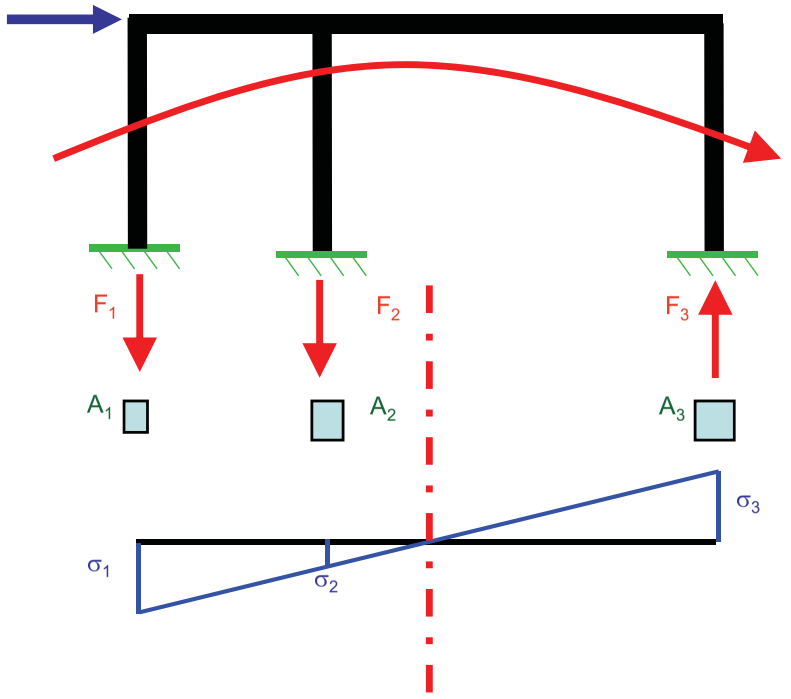


232

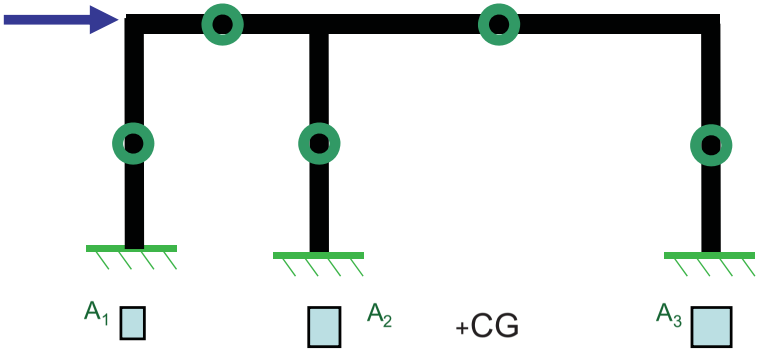
بســـم اللـــــه الرحمـــن الرحيـــم

Approximate Method

Cantilever Method

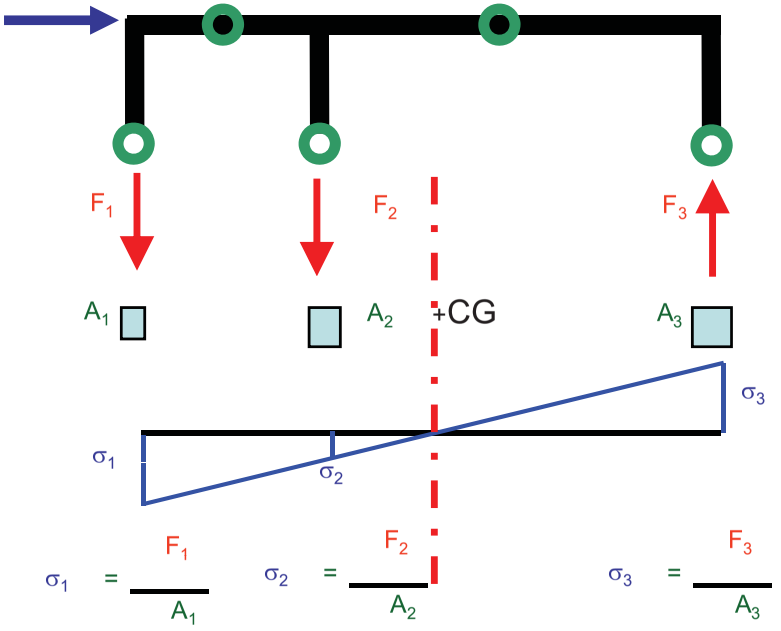


Solution Steps :



$$x_{CG} = \frac{\Sigma A x}{\Sigma A}$$

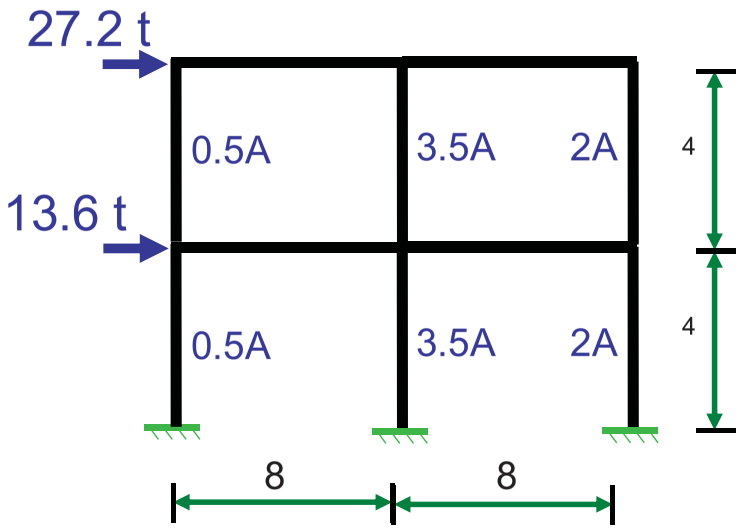
Solution Steps :

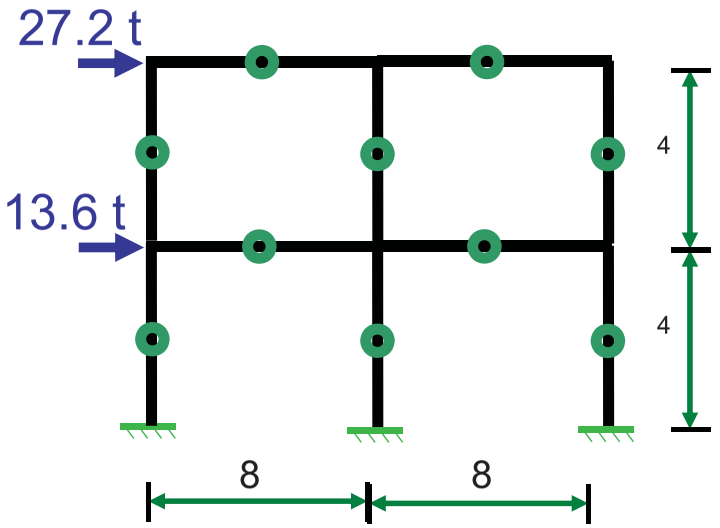


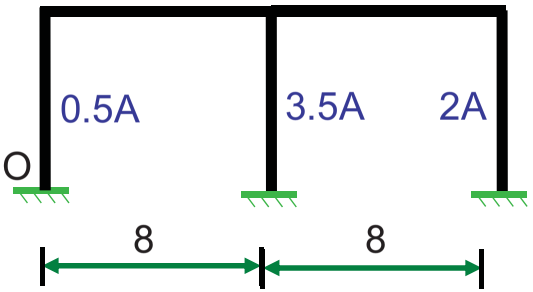
$$\sigma_1 = \frac{F_1}{A_1} \qquad \sigma_2 = \frac{F_2}{A_2} \qquad \sigma_3 = \frac{F_3}{A_3}$$

Example 1 :

Draw B.M, S.F & N.F.D^{s} for the shown frame



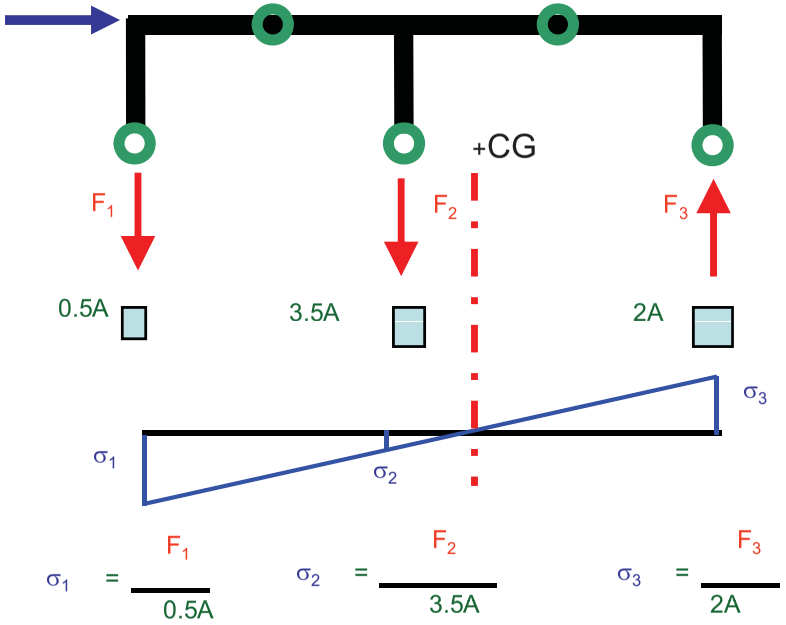




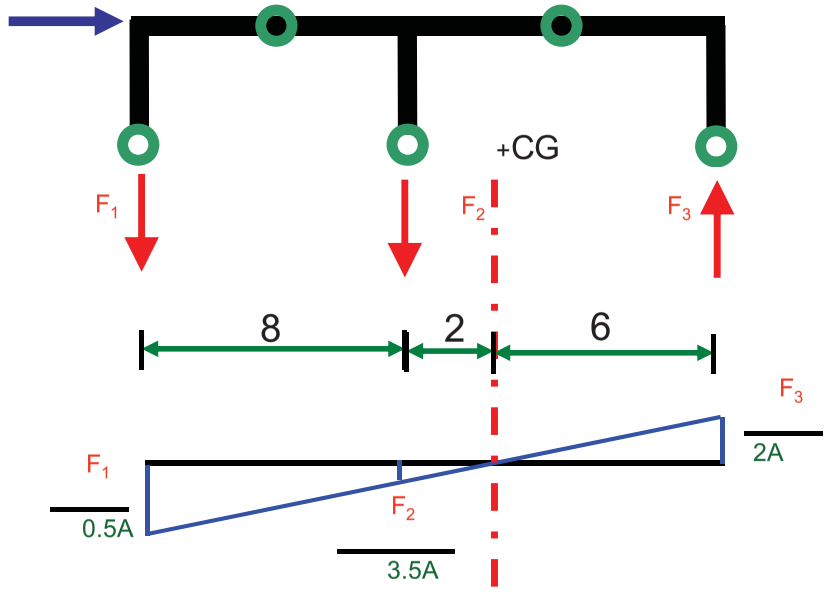
$$x_{CG} = \frac{\Sigma A x}{\Sigma A}$$

$$x_{CG} = \frac{0.5A \times 0 + 3.5A \times 8 + 2A \times 16}{0.5A+3.5A+2A} = \frac{60\,A}{6\,A}$$

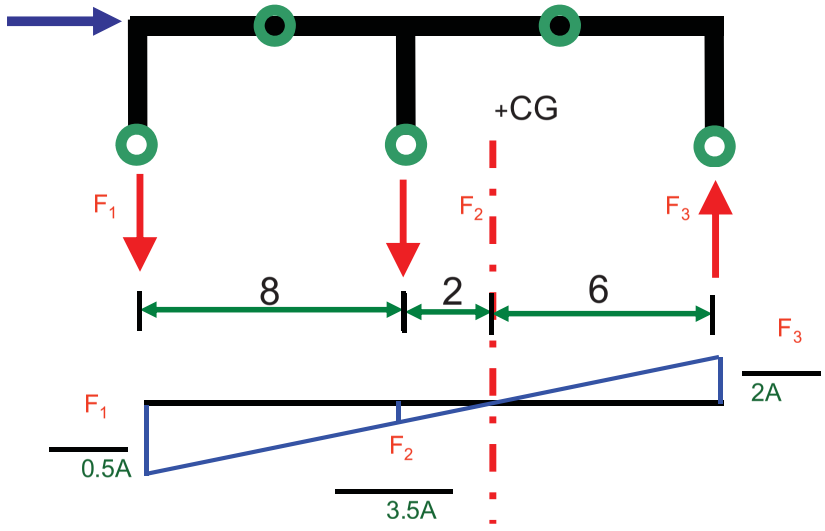
$$= 10 \text{ m}$$



$$\sigma_1 = \frac{F_1}{0.5A} \qquad \sigma_2 = \frac{F_2}{3.5A} \qquad \sigma_3 = \frac{F_3}{2A}$$

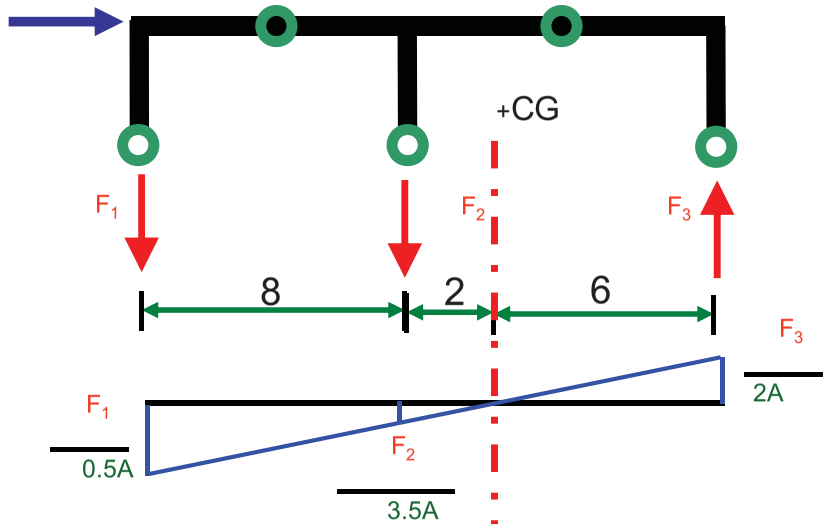


241



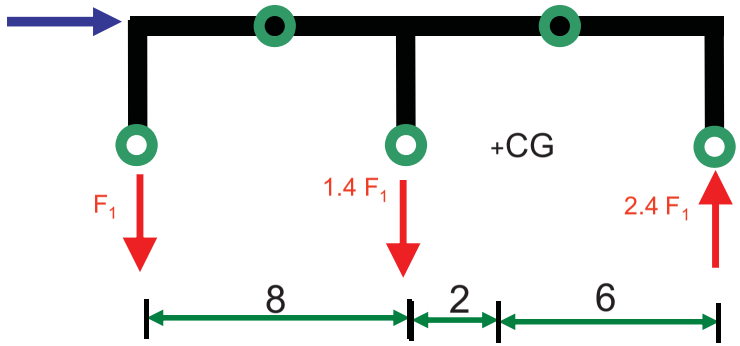
$$\frac{\frac{F_2}{3.5A}}{\frac{F_1}{0.5A}} = \frac{2}{10} \qquad \frac{F_2}{3.5A} = \frac{2}{10}\,\frac{F_1}{0.5A} \qquad F_2 = 1.4\,F_1$$

242



$$\frac{\frac{F_3}{2A}}{\frac{F_1}{0.5A}} = \frac{6}{10} \qquad \frac{F_3}{2A} = \frac{6}{10}\,\frac{F_1}{0.5A} \qquad F_3 = 2.4\,F_1$$

243

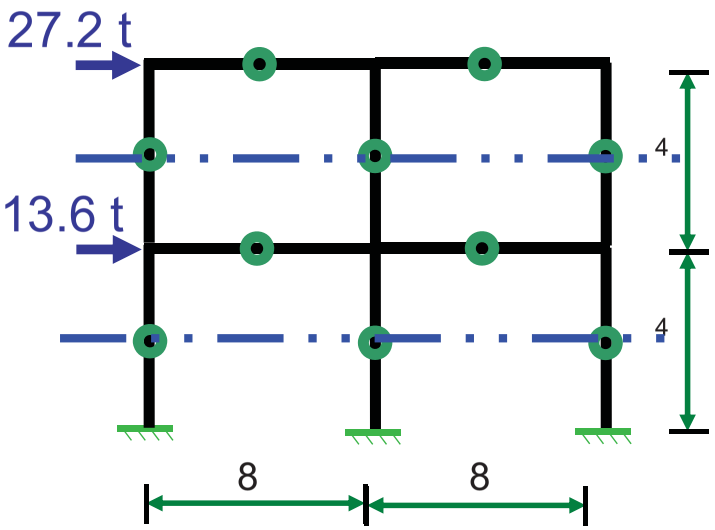


$M_{reaction} = M_{action}$ About CG

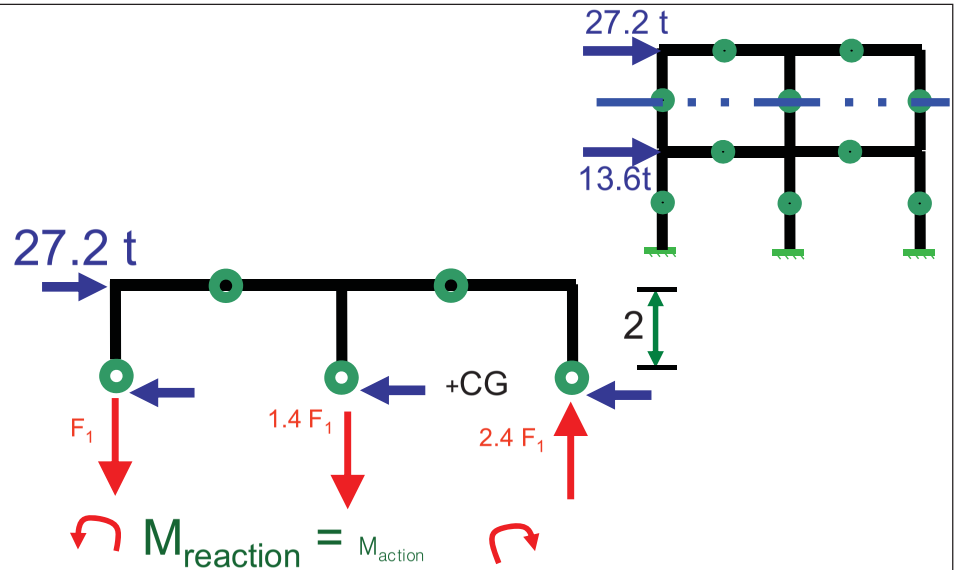
$$M_{reaction} = 10xF_1 + 2x1.4\,F_1 + 6x2.4F_1$$

$$= 27.2\,F_1$$

244



245

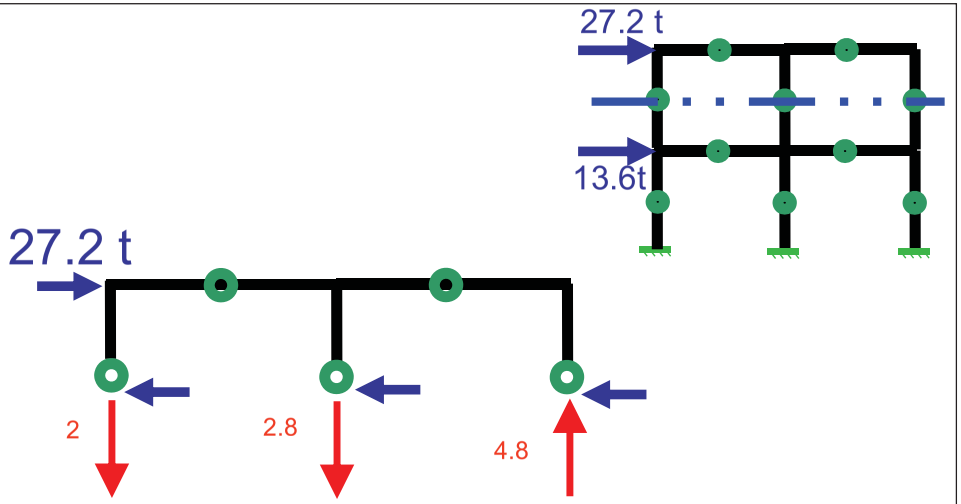


$M_{reaction} = M_{action}$

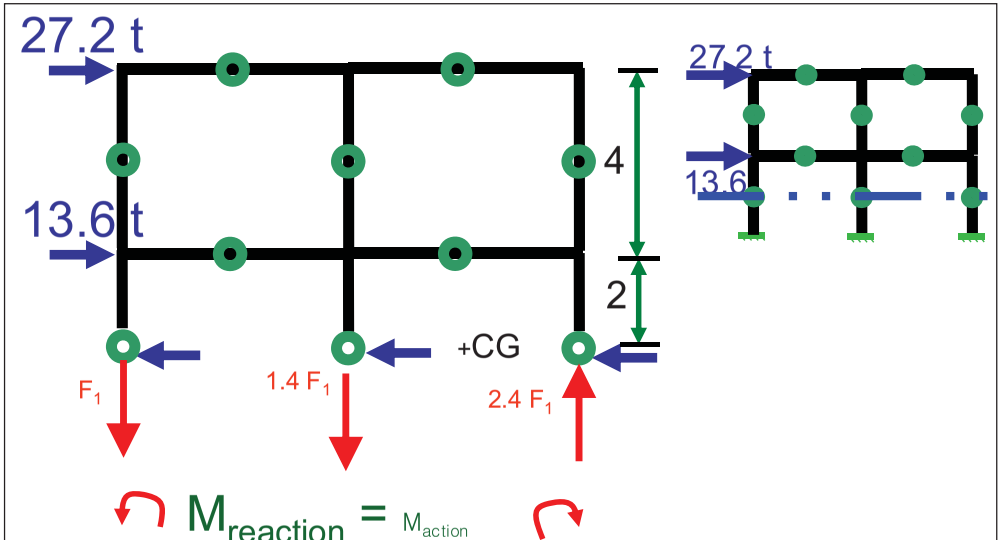
$27.2\ F_1 = 27.2 \times 2$

$F_1 = 2$ t

246



247

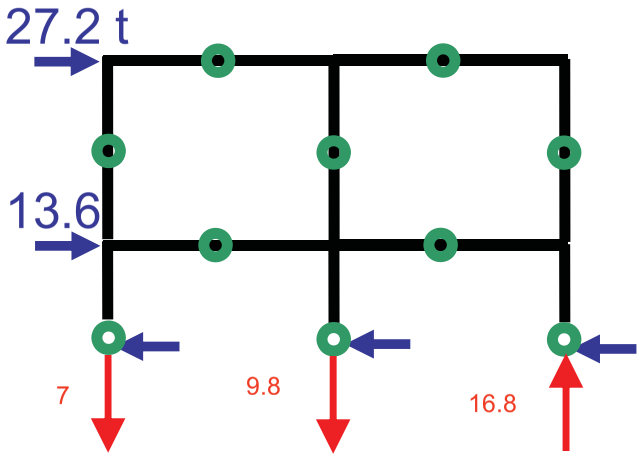


$M_{reaction} = M_{action}$

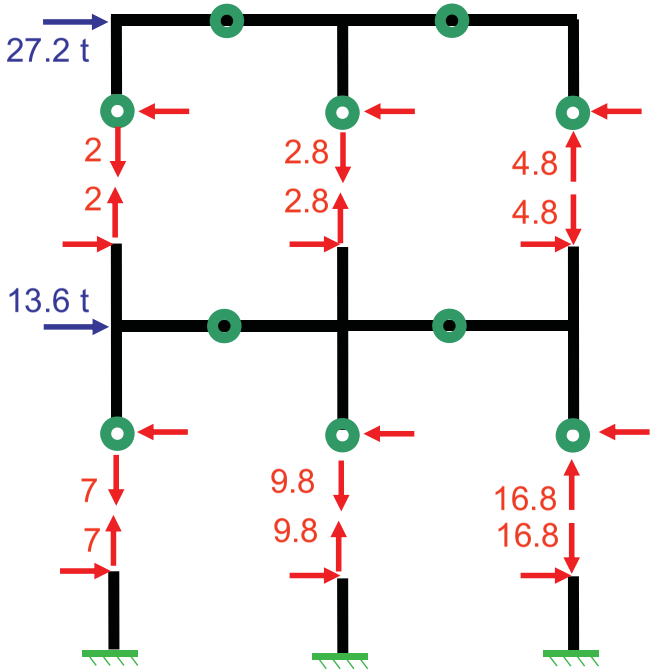
$27.2\ F_1 = 27.2 \times 6 + 13.6 \times 2$

$F_1 = 7$ t

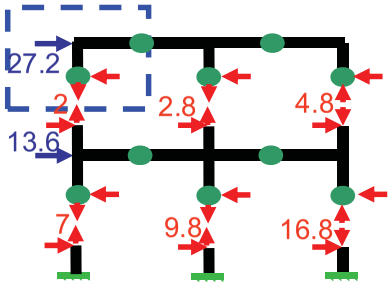
248

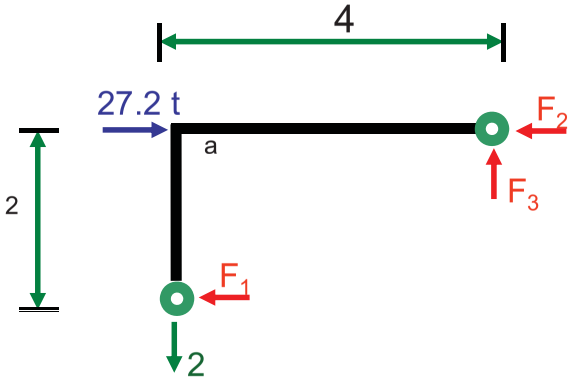


249



250





$\Sigma F_y = 0$

$F_3 = 2$ t

$\Sigma M_@ = 0$

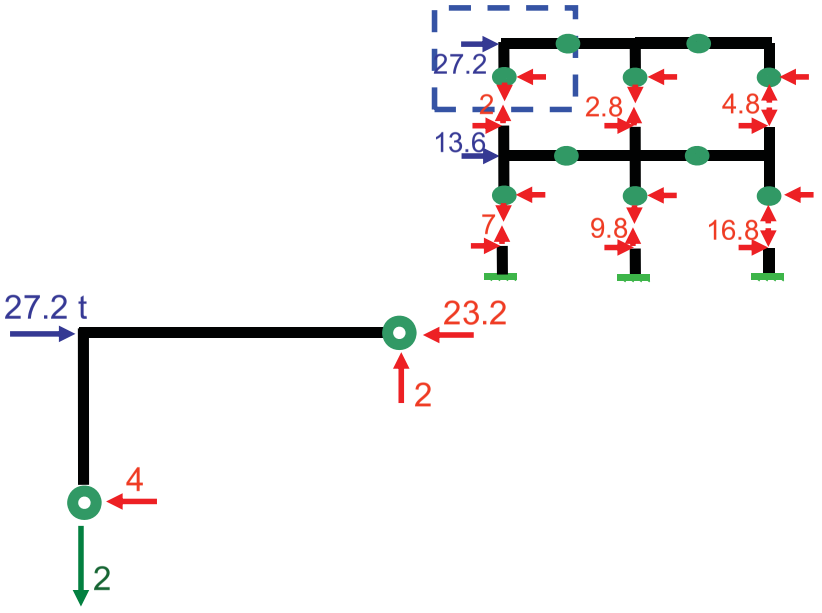
$4 F_3 = 2 F_1$

$F_1 = 4$

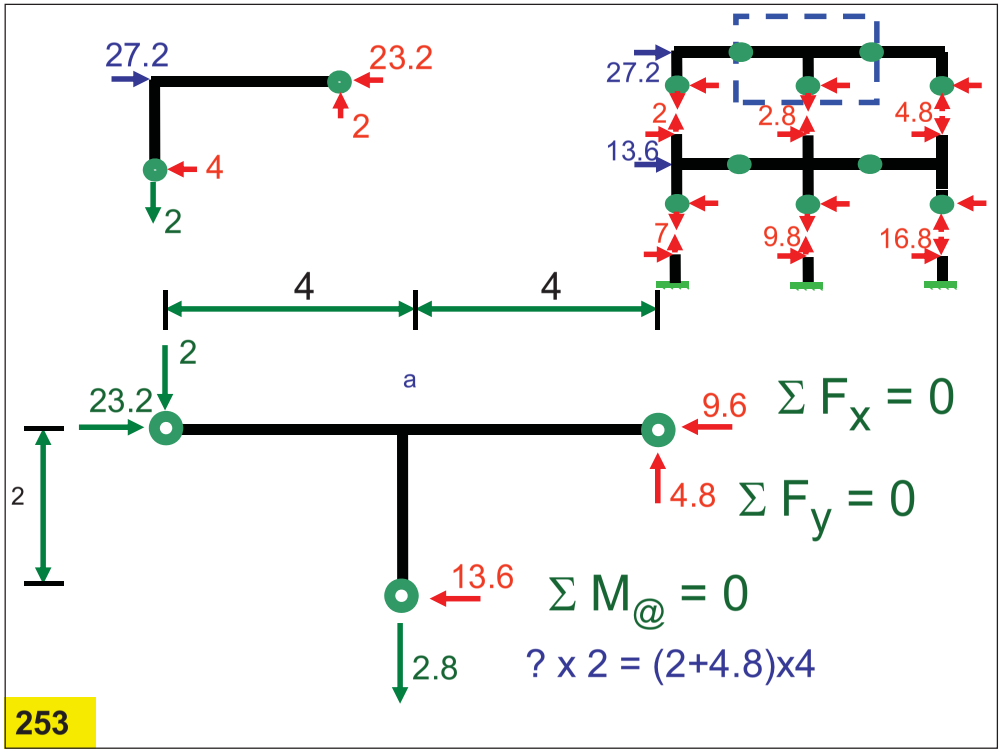
$\Sigma F_x = 0$

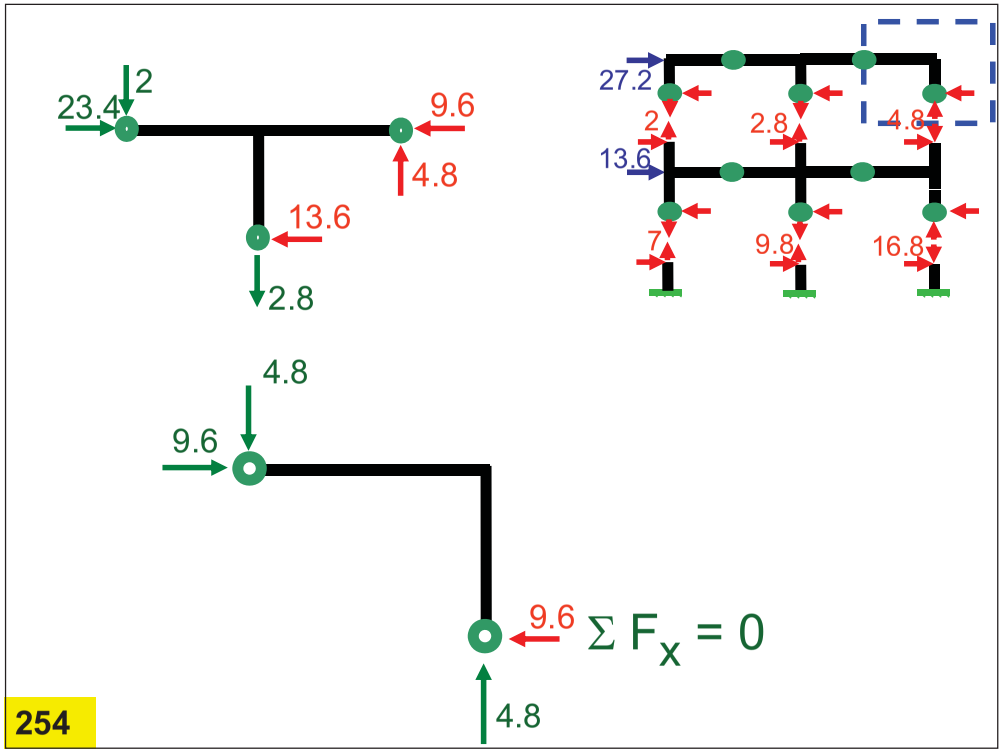
$F_2 = 23.2$ t

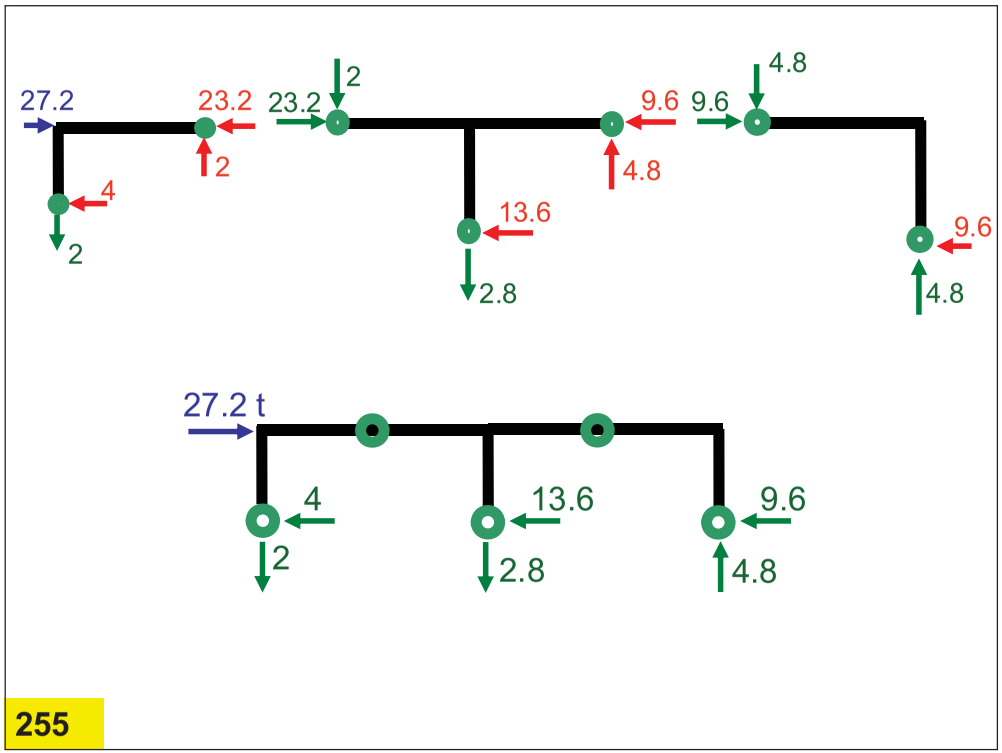
251

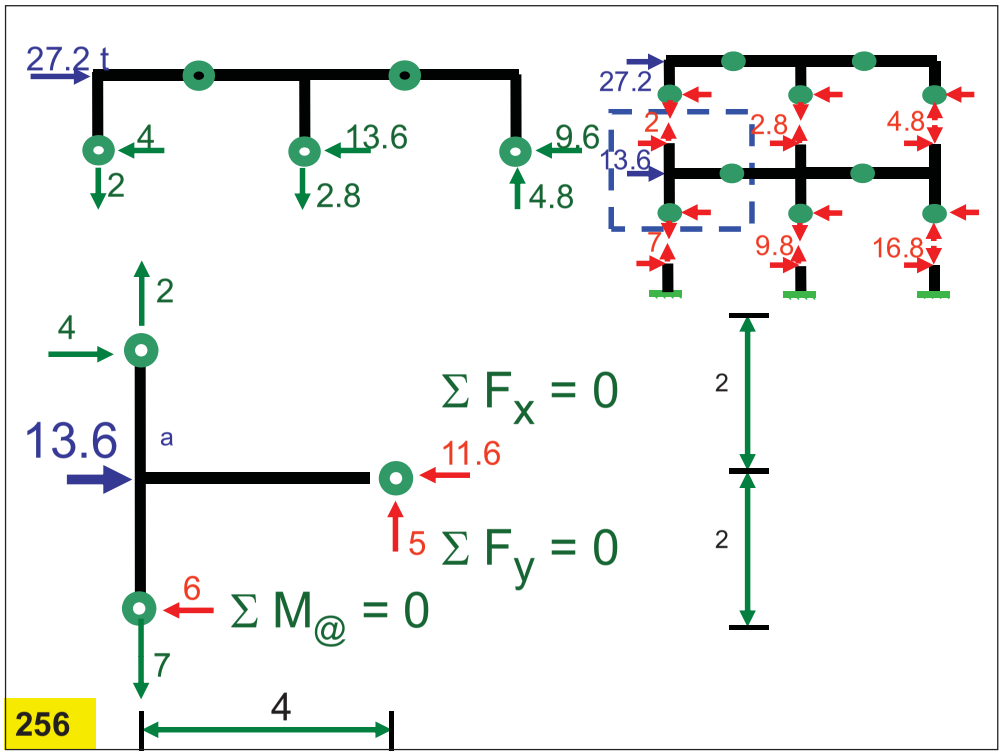


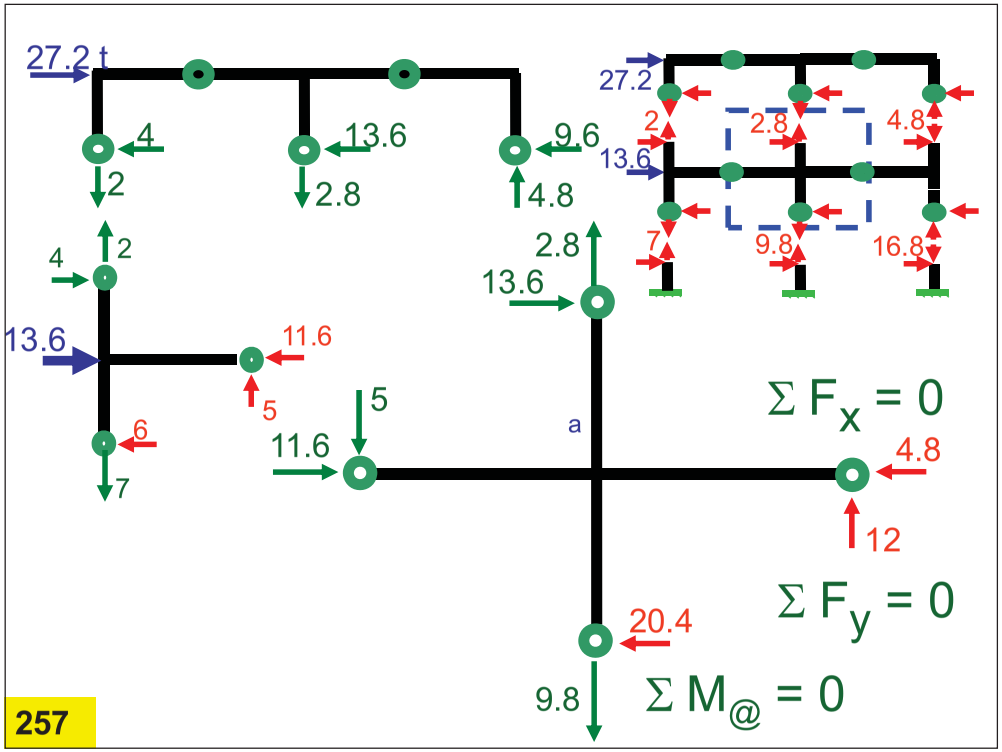
252

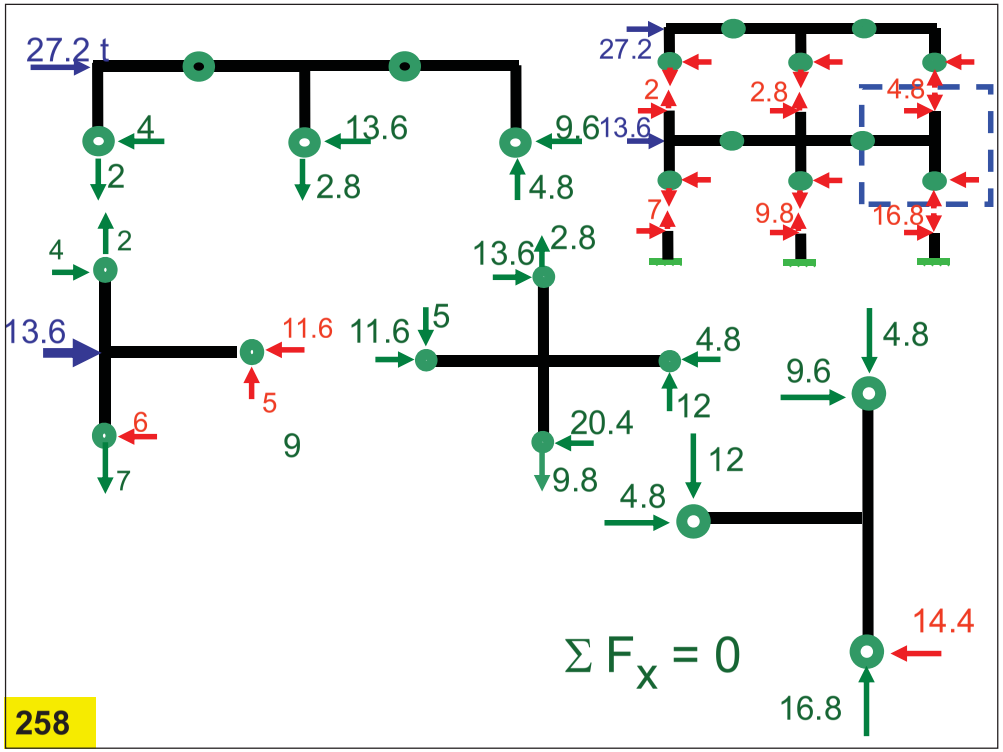

27.2
23.2
2
4
2
27.2
2
2.8
4.8
13.6
7
9.8
16.8
4
4
2
a
23.2
9.6
4.8
2
13.6
2.8
Σ Fx = 0
Σ Fy = 0
Σ M@ = 0
? x 2 = (2+4.8)x4
253

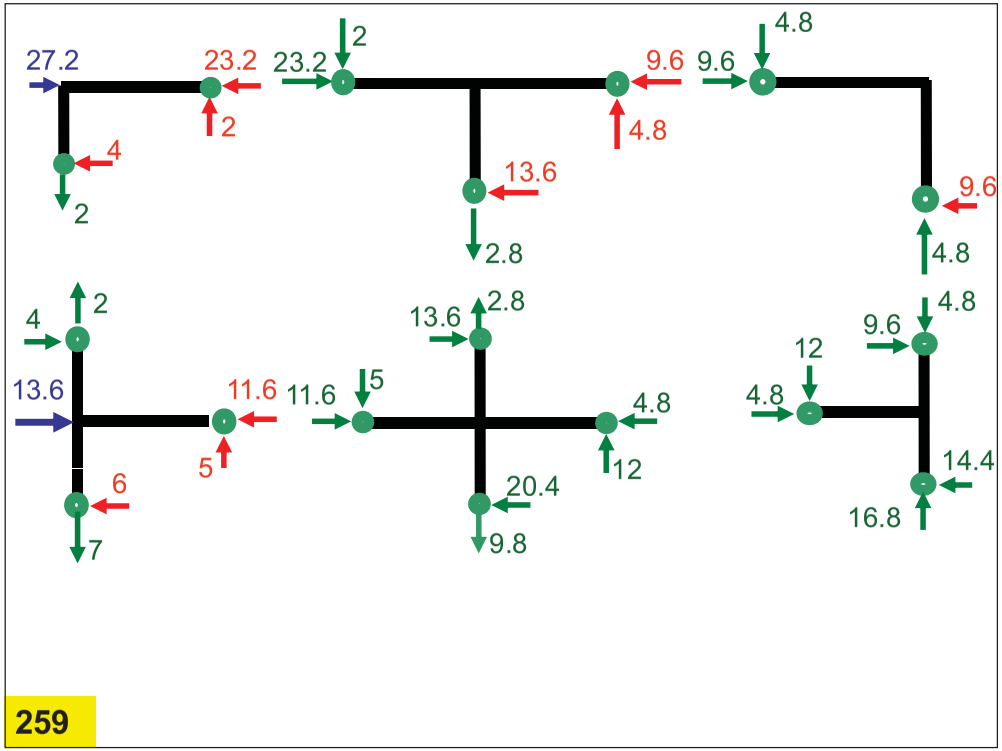

23.4
2
9.6
4.8
13.6
2.8
27.2
2
2.8
4.8
13.6
7
9.8
16.8
4.8
9.6
9.6
Σ Fx = 0
4.8
254

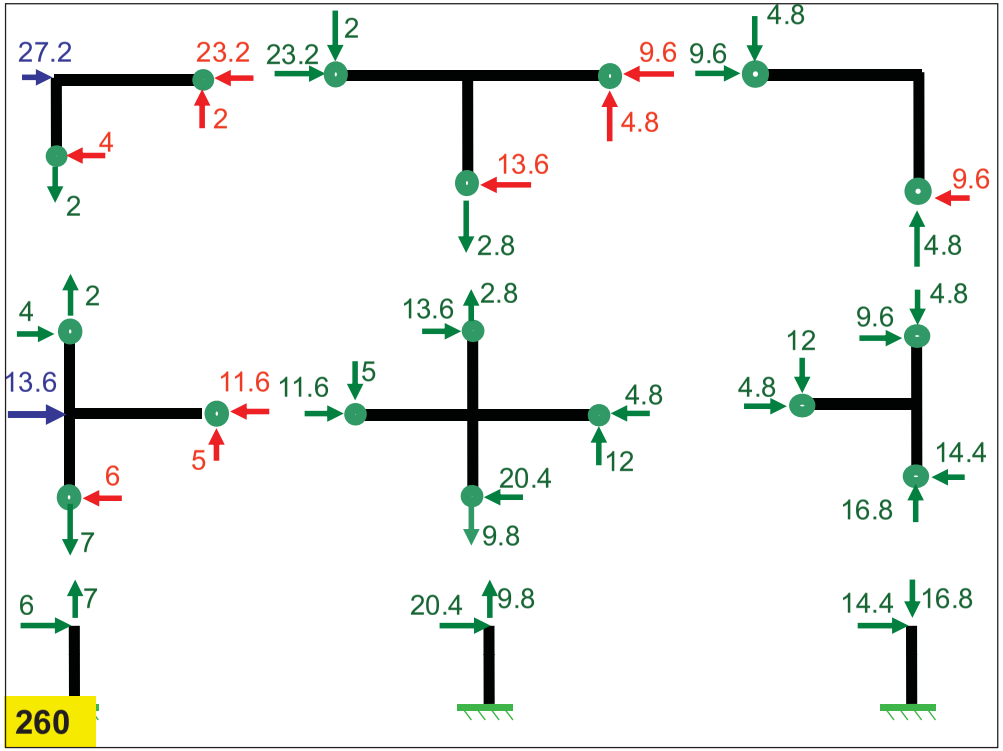

27.2
23.2
4
2
2
23.2
2
9.6
4.8
13.6
2.8
9.6
4.8
27.2 t
4
2
13.6
2.8
9.6
4.8
255

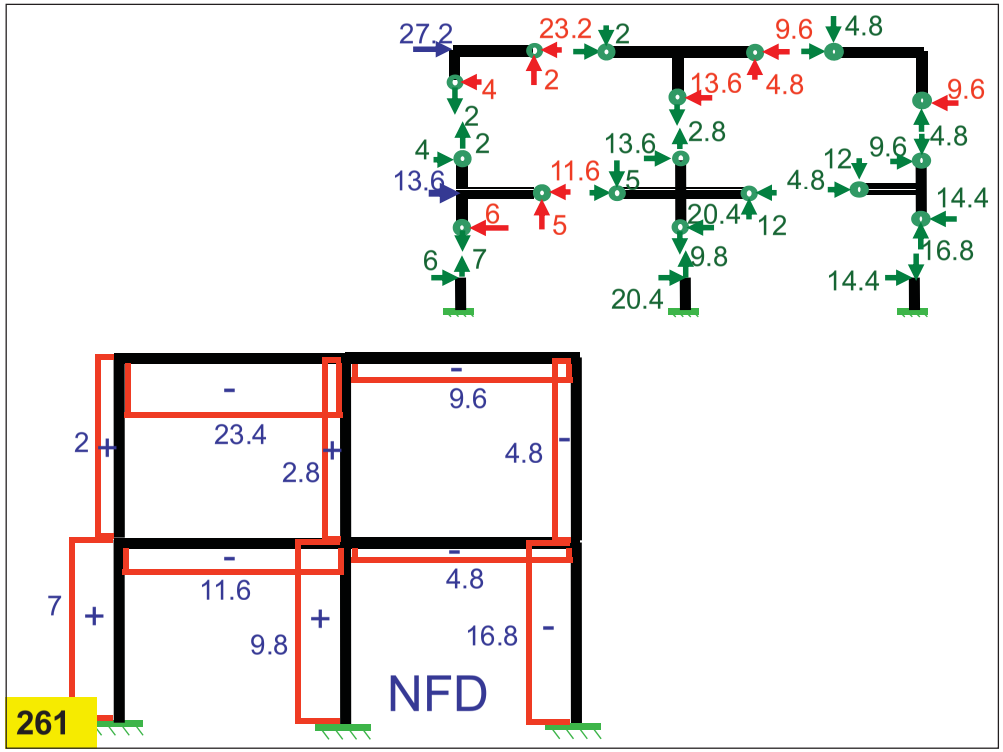

27.2 t
4
2
13.6
2.8
9.6
4.8
27.2
2
2.8
4.8
13.6
7
9.8
16.8
2
4
13.6
a
11.6
5
6
7
4
2
2
Σ Fx = 0
Σ Fy = 0
Σ M@ = 0
256

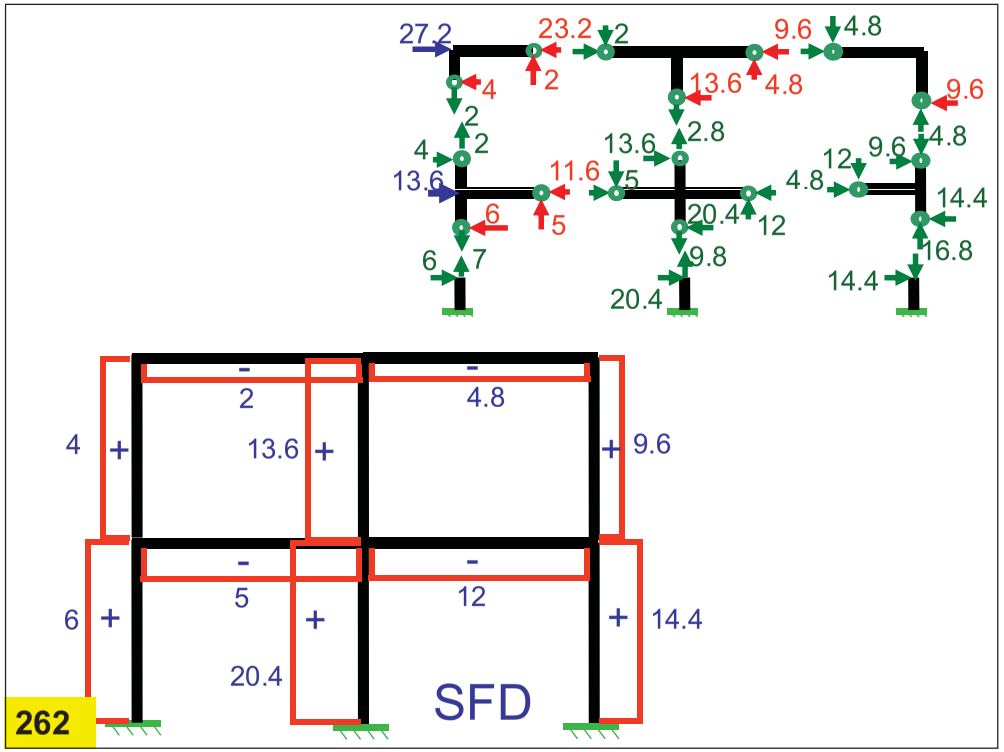

27.2 t
4
13.6
9.6
2
2.8
4.8
27.2
2
2.8
4.8
13.6
7
9.8
16.8
2.8
13.6
4
2
13.6
11.6
5
6
7
11.6
5
a
4.8
12
20.4
9.8
Σ Fx = 0
Σ Fy = 0
Σ M@ = 0
257

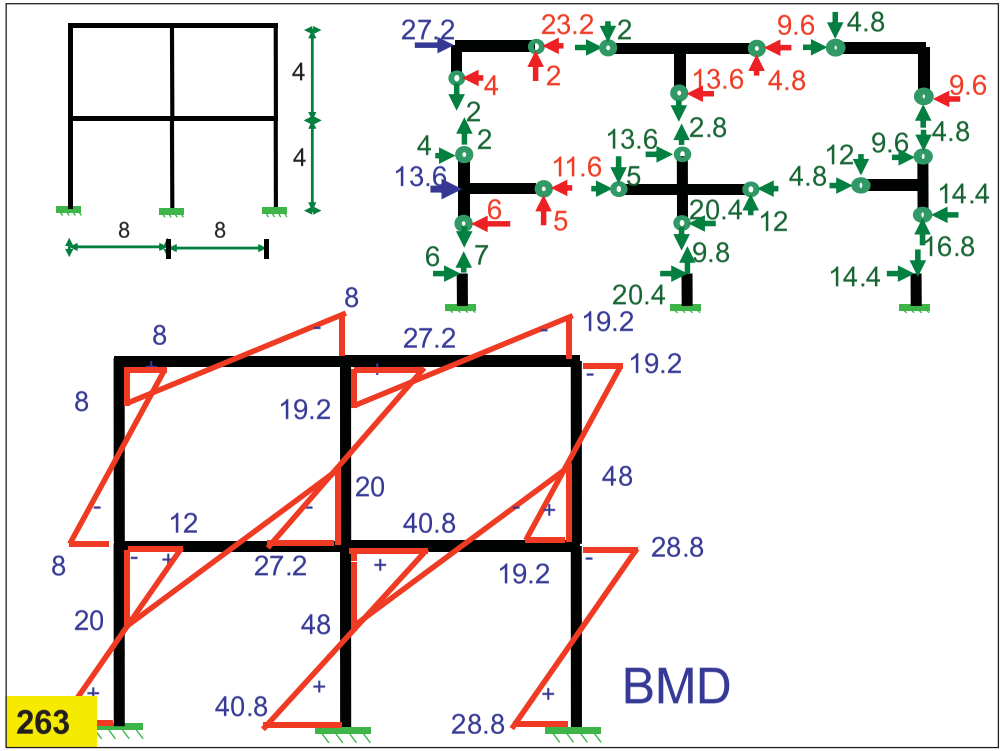

27.2 t
4
13.6
9.6
2
2.8
4.8
27.2
2
2.8
4.8
13.6
7
9.8
16.8
4
2
13.6
11.6
5
6
9
7
13.6
2.8
11.6
5
4.8
20.4
12
9.8
9.6
4.8
12
4.8
14.4
16.8
Σ Fx = 0
258


27.2
23.2
2
23.2
2
9.6
4.8
9.6
4.8
4
2
13.6
2.8
9.6
4.8
4
2
13.6
11.6
5
6
7
13.6
2.8
11.6
5
4.8
20.4
12
9.8
9.6
4.8
12
4.8
14.4
16.8
259


27.2
23.2
2
23.2
2
9.6
4.8
9.6
4.8
4
2
13.6
2.8
9.6
4.8
4
2
13.6
11.6
5
6
7
13.6
2.8
11.6
5
4.8
20.4
12
9.8
9.6
4.8
12
4.8
14.4
16.8
6
7
20.4
9.8
14.4
16.8
260







بسـم اللـه الرحمـن الرحيـم

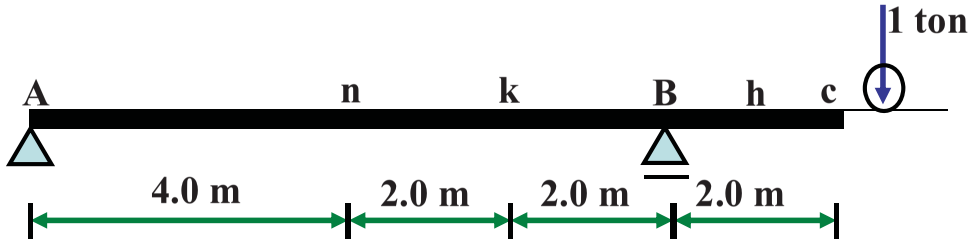
Influence line

Beams

264

determinate structure مقدمة عن المنشآت الـ

Influence line for determinate structures



Draw the influence lines for:

1- y_a and y_b

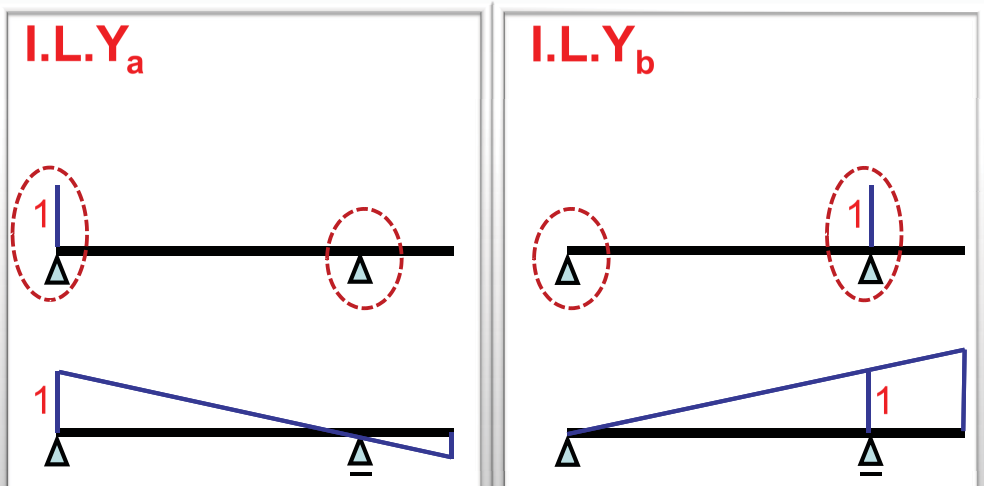
2- Q_n , Q_k , Q_{bR} and Q_{bL}

3- M_n , M_k and M_b

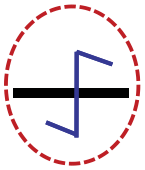
265

I.L.Y

عند رسم الـ ILY لل reaction يتم عمل ازاحة لأعلى بمقدار الوحده مع ترك باقى النقط كما هى

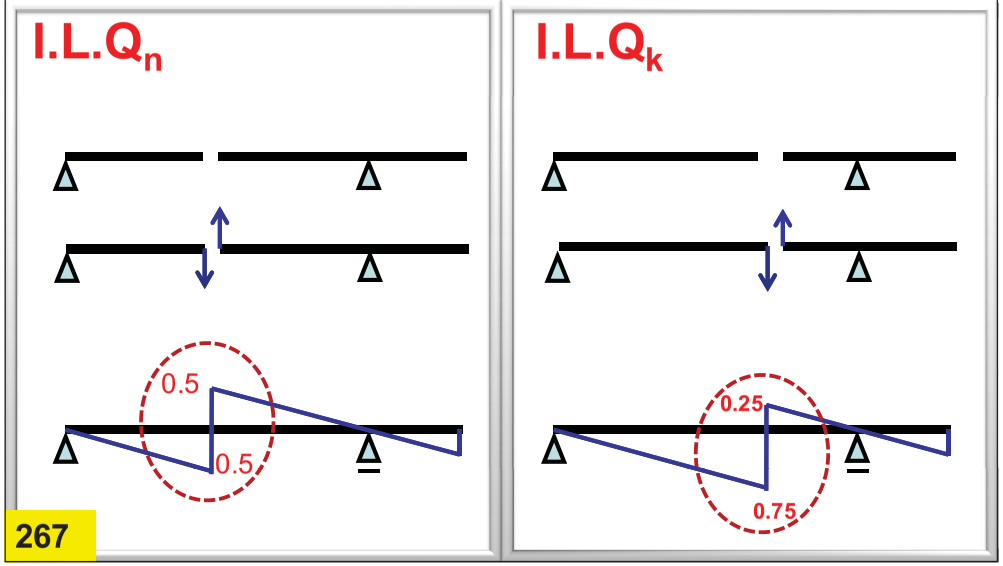


266

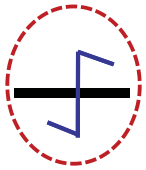


I.L.Q

عند رسم الـ IL للـ shear يتم عمل قطع فى النقطة المطلوبة ويتم رفع النقطه اليمين وخفض النقطة الشمال مع بقاء باقى النقط فى اماكنها

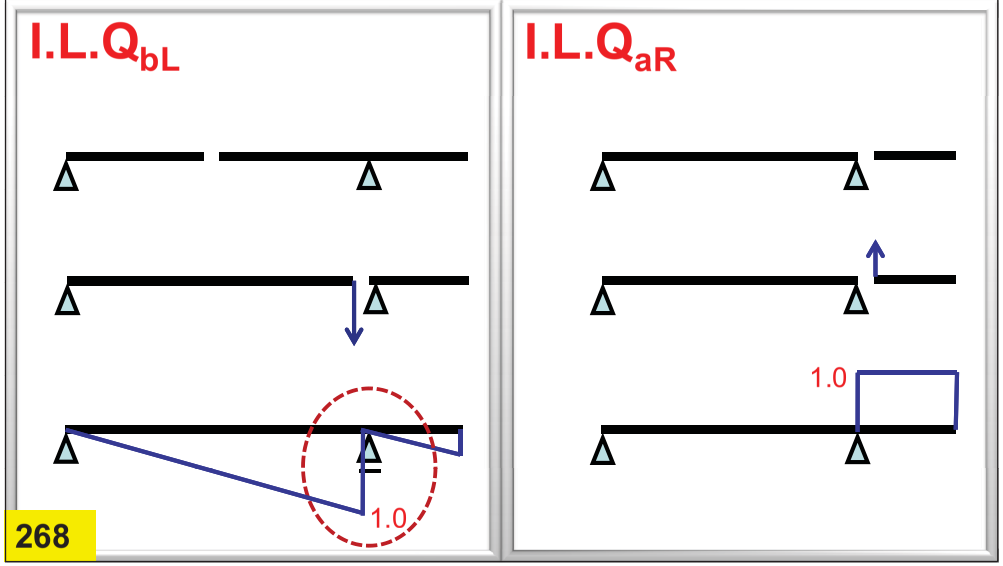


267



I.L.Q

عند رسم الـ IL للـ shear يتم عمل قطع فى النقطة المطلوبة ويتم رفع النقطه اليمين وخفض النقطة الشمال مع بقاء باقى النقط فى اماكنها

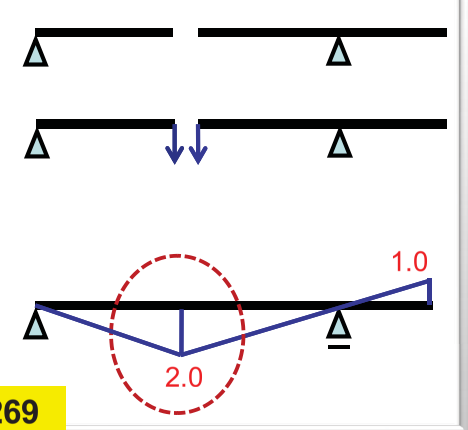


268

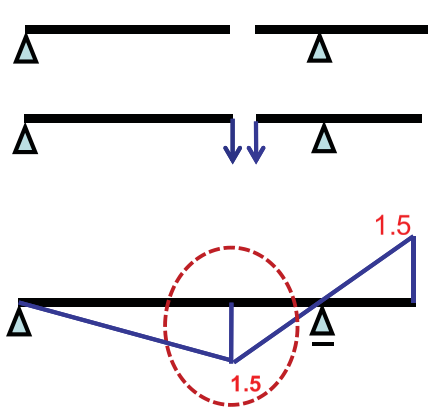
I.L.M

عند رسم الـ IL للـ Moment يتم عمل قطع فى النقطة المطلوبة ويتم خفض النقطة يمين وشمال مع بقاء باقى النقط فى اماكنها لعمل زاوية θ

$I.L.M_n$



$I.L.M_k$

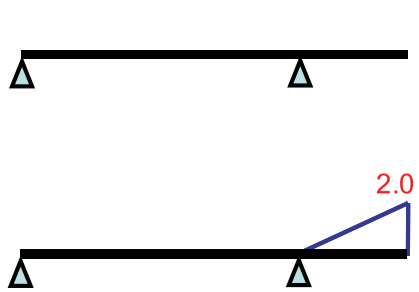


269

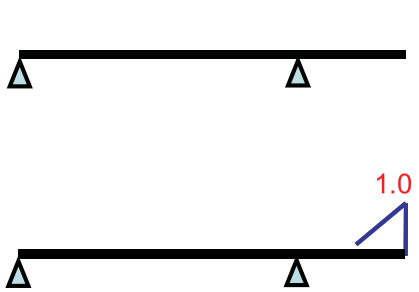
I.L.M

عند رسم الـ IL للـ Moment يتم عمل قطع فى النقطة المطلوبة ويتم خفض النقطة يمين وشمال مع بقاء باقى النقط فى اماكنها لعمل زاوية θ

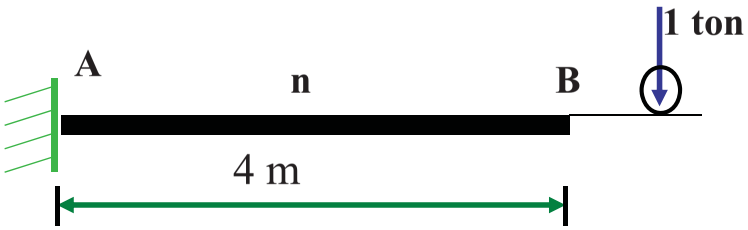
$I.L.M_b$



$I.L.M_h$



270



Draw the influence lines for:

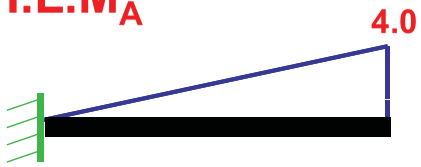
1- y_a
2- Q_n
3- M_A , M_n

271

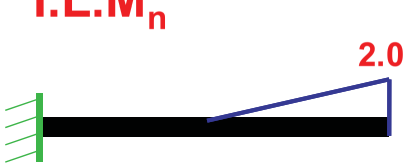
$I.L.Y_A$

$I.L.Q_n$

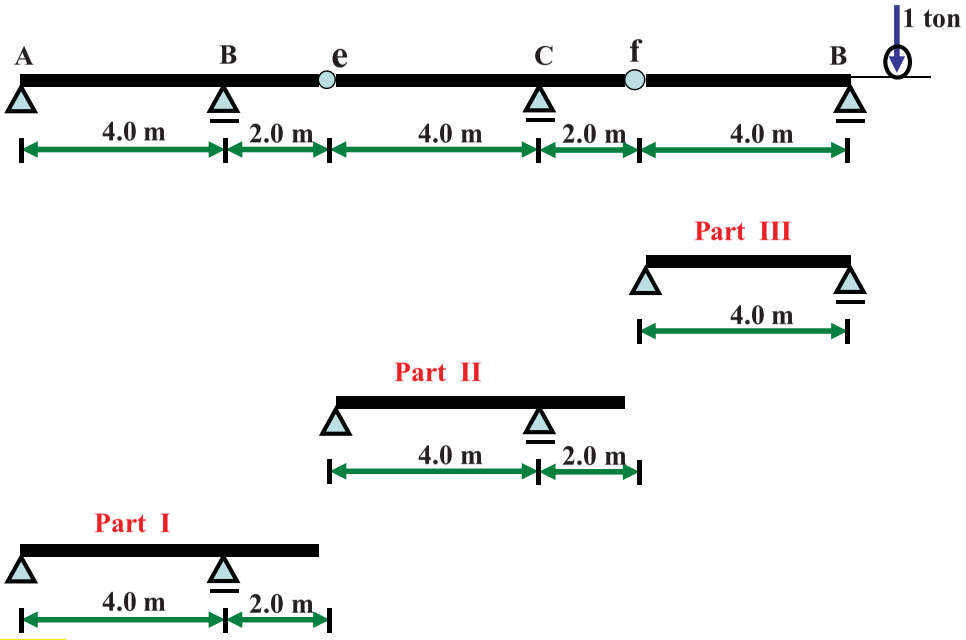
$I.L.M_A$



$I.L.M_n$

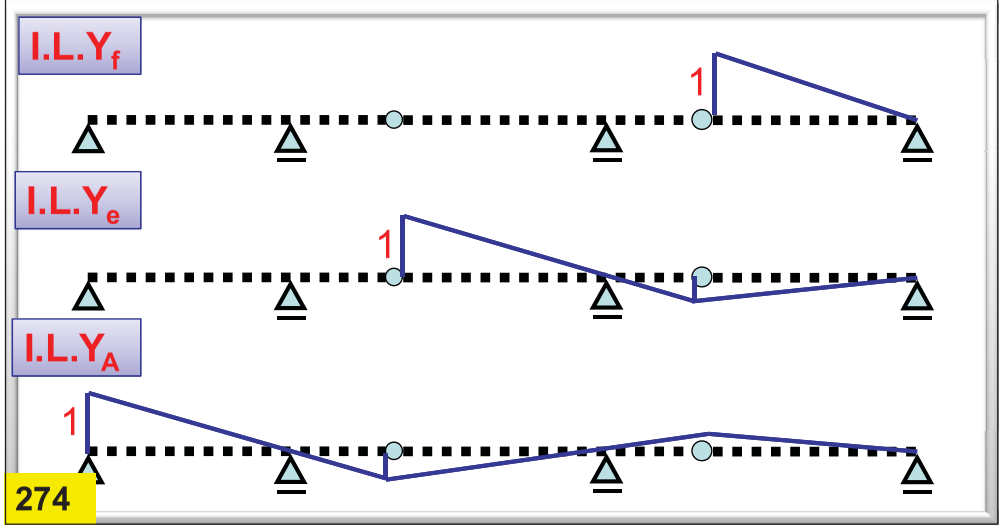


272



عند الرسم على الـ compound beam يتم الرسم على الجزء وما يحمله هو

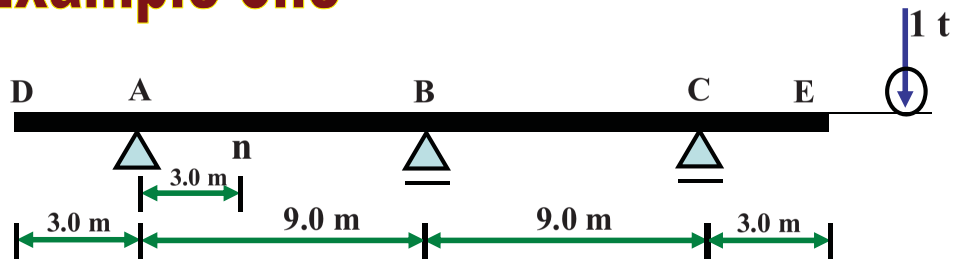
مثلا الرسم على part III يكون عليه فقط
الرسم على part II يكون عليه وعلى part III
الرسم على Part I يكون عليه وعلى part II وعلى part III



Influence line

For Indeterminate structures

Example one

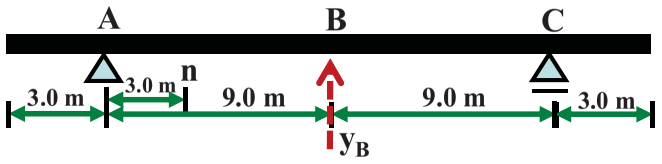


Draw the influence lines for:

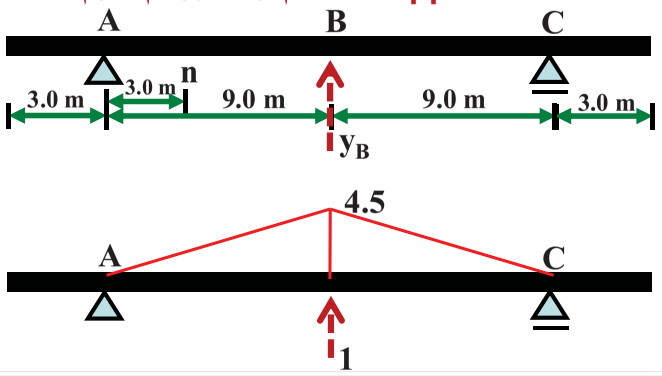
1- y_a and y_b
2- Q_n , Q_{bR}, Q_{bL} and Q_{CR}
3- M_n , M_C and M_b

خطوات الحل:

1- يتم عمل main system بازالة المجهول الزياده.



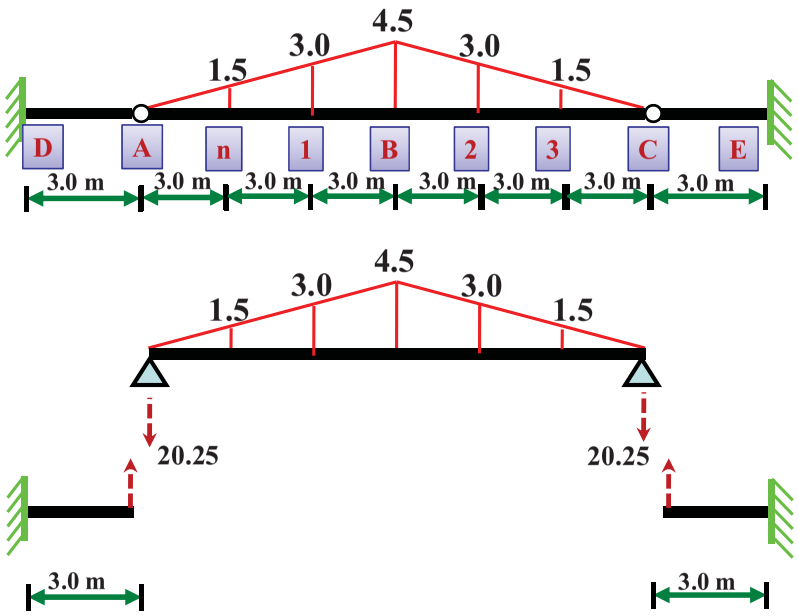
2- يتم وضع 1 ton مكان الـ support الذى تم ازالته ورسم العزم m_0

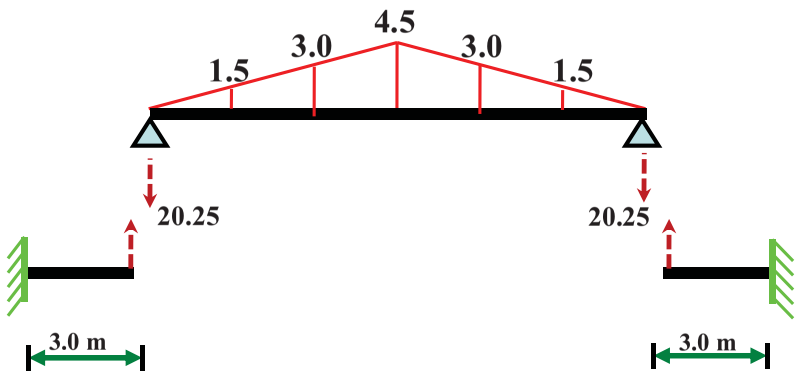


3- يتم تحويل الكمرة الى conjugate beam

Real Beam Support	Conjugate Beam Support
Hinged Support	Hinged Support
Roller Support	Roller Support
Fixed Support	Free End
Free End	Fixed Support
Interior Support	Internal Hinge
Internal Hinge	Interior Support

4 - يتم عمل تقسيم للكمرة الى اجزاء متساوية وحساب العزوم عند هذة الاقسام.





$M_d = 20.25 * 3 = 60.75$

$M_A = 0.0$

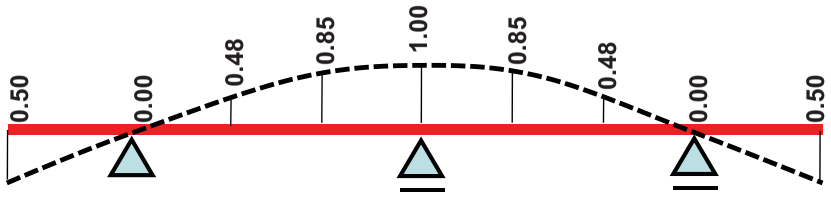
$M_n = -20.25 * 3 + (0.5*1.5*3)*1 = -58.5$

$M_1 = -20.25 * 6 + (0.5*3.0*6)*2 = -103.5$

$M_B = -20.25 * 9 + (0.5*4.5*9)*3 = -121.5$

$M_d = 60.75$		$\delta_d = -0.5$
$M_A = 0.0$		$\delta_A = 0.0$
$M_n = -58.5$		$\delta_n = 0.48$
$M_1 = -103.5$		$\delta_1 = 0.85$
$M_B = -121.5$	يتم قسمة كل العزوم على MB للحصول على δ	$\delta_B = 1.0$
$M_2 = -103.5$		$\delta_2 = 0.85$
$M_3 = -58.5$		$\delta_3 = 0.48$
$M_C = 0.0$		$\delta_C = 0.0$
$M_e = 60.75$		$\delta_e = -0.5$

ILY_B

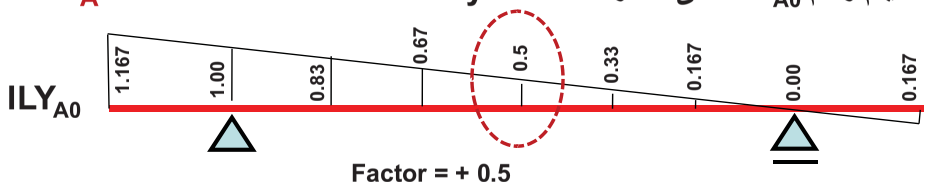


281

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

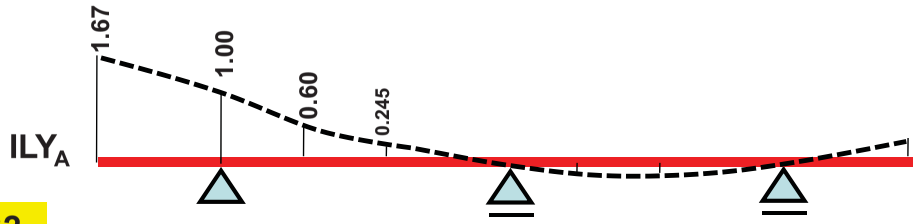
$I.L.Y_A$

1- يتم رسم ILY_{A0} على الكمرة الـ Main system



$I.L.Y_A = I.L.Y_{A0} - factor * I.L.Y_B$

$= I.L.Y_{A0} - 0.5 * I.L.Y_B$

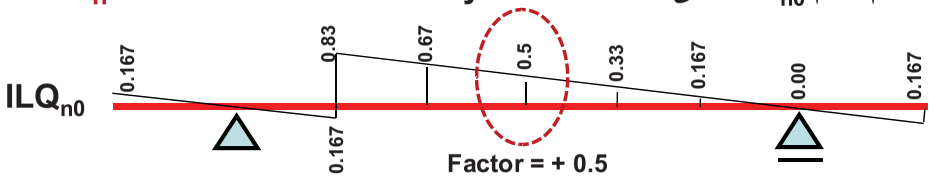


282

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

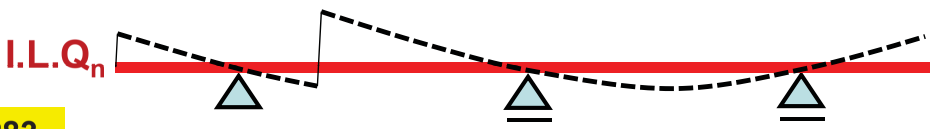
$I.L.Q_n$

2- يتم رسم ILQ_{n0} على الكمرة الـ Main system



$I.L.Q_n = I.L.Q_{n0} - factor * I.L.Y_B$

$= I.L.Q_{n0} - 0.5 * I.L.Y_B$

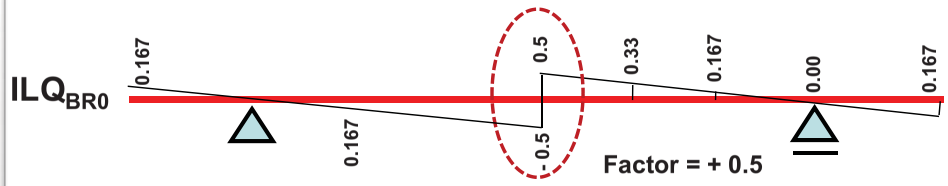


283

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

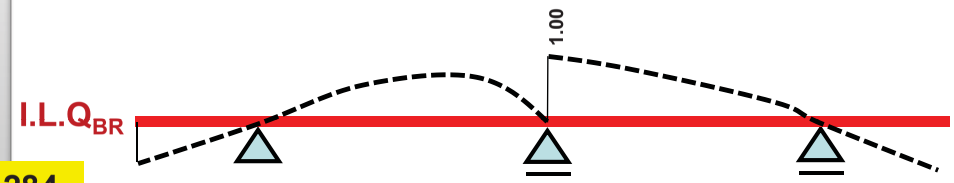
$I.L.Q_{BR}$

3- يتم رسم ILQ_{BR0} على الكمرة الـ Main system



$I.L.Q_{BR} = I.L.Q_{BR0} - factor * I.L.Y_B$

$= I.L.Q_{BR0} - 0.5 * I.L.Y_B$

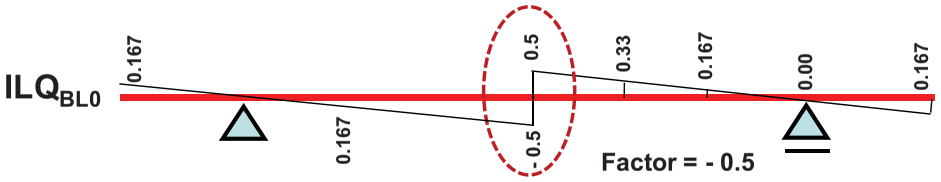


284

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

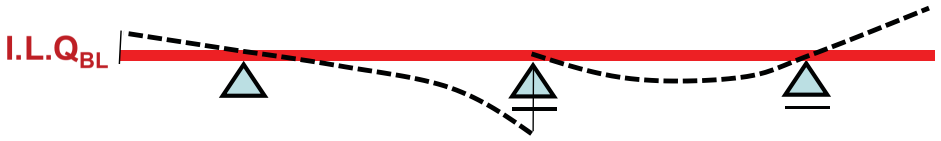
I.L.Q_{BL}

-4 يتم رسم ILQ_{BL0} على الكمرة الـ Main system



$I.L.Q_{BL} = I.L.Q_{BL0} - factor * I.L.Y_B$

$= I.L.Q_{BL0} + 0.5 * I.L.Y_B$

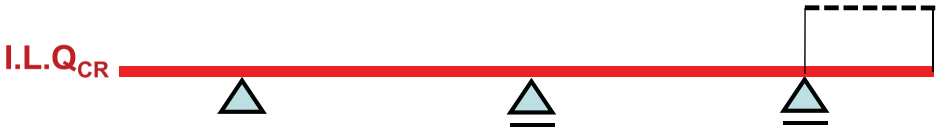


285

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

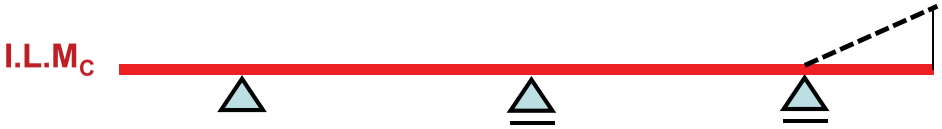
I.L.Q_{CR}

-5 هذا المطلوب derterminate



I.L.M_C

-6 هذا المطلوب derterminate

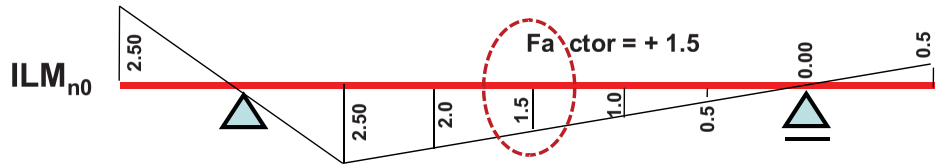


286

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

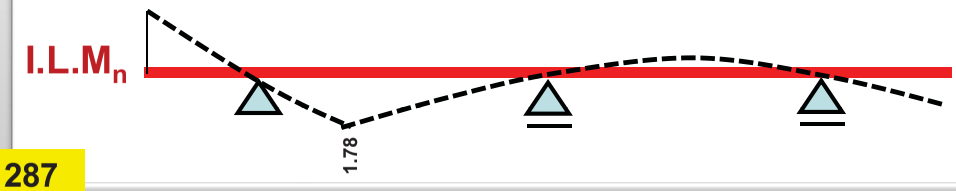
I.L.M_n

-7 يتم رسم ILM_{n0} على الكمرة الـ Main system



$I.L.M_n = I.L.M_{n0} - factor * I.L.Y_B$

$= I.L.M_{n0} - 1.5 * I.L.Y_B$

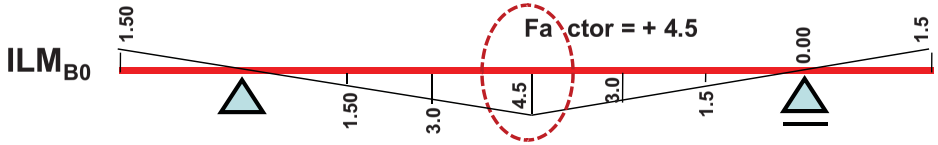


287

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

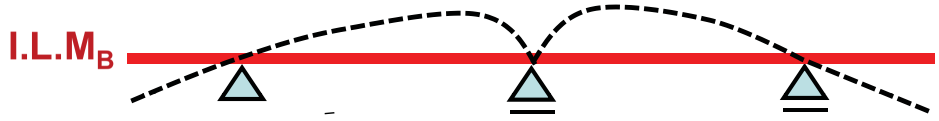
I.L.M_B

-8 يتم رسم ILM_{B0} على الكمرة الـ Main system



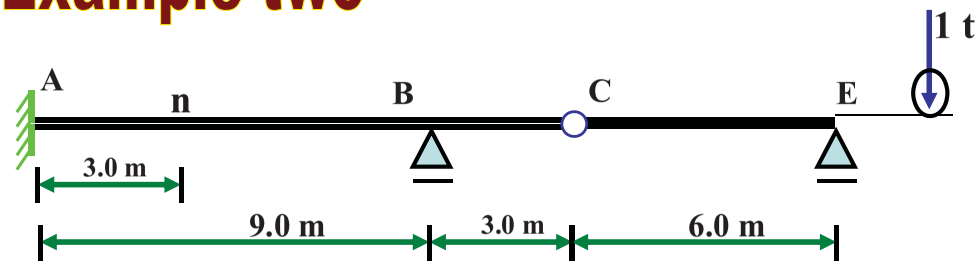
$I.L.M_B = I.L.M_{B0} - factor * I.L.Y_B$

$= I.L.M_{B0} - 4.5 * I.L.Y_B$



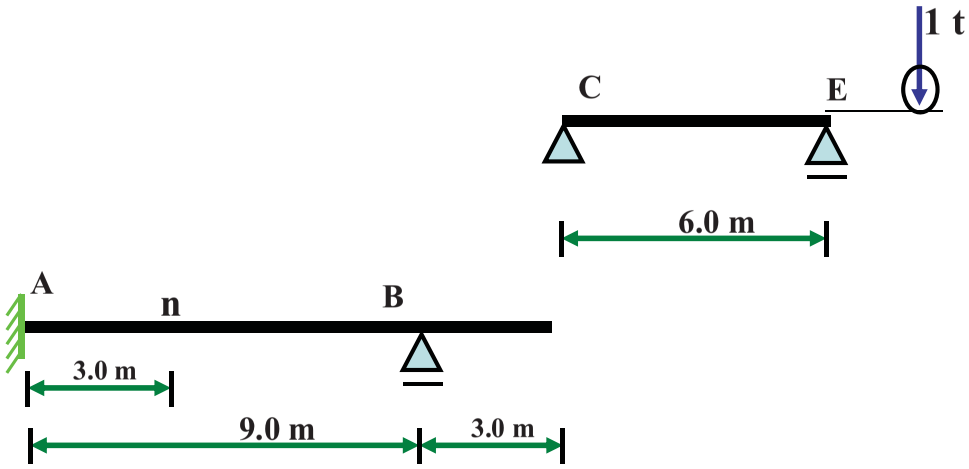
288

Example two

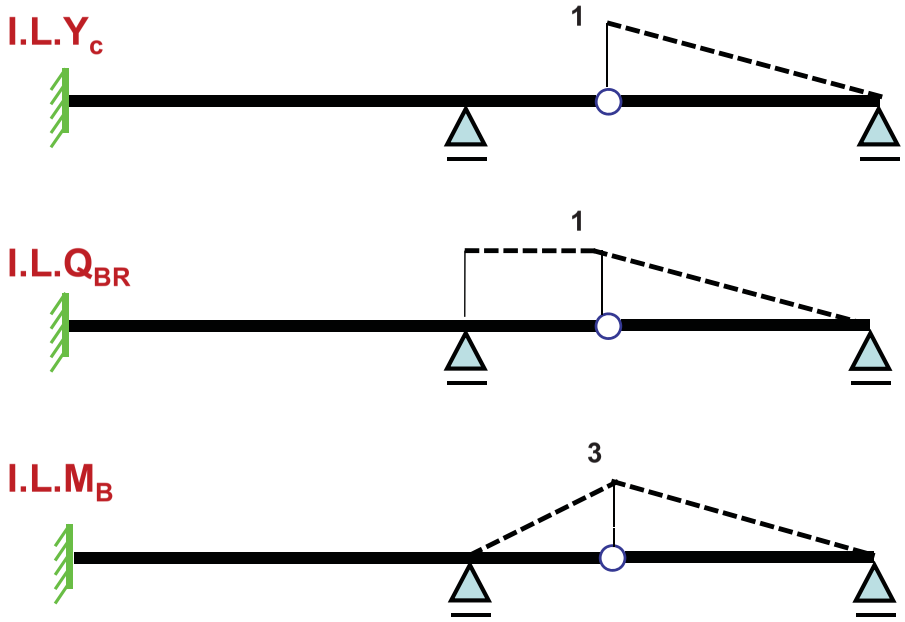


Draw the influence lines for:

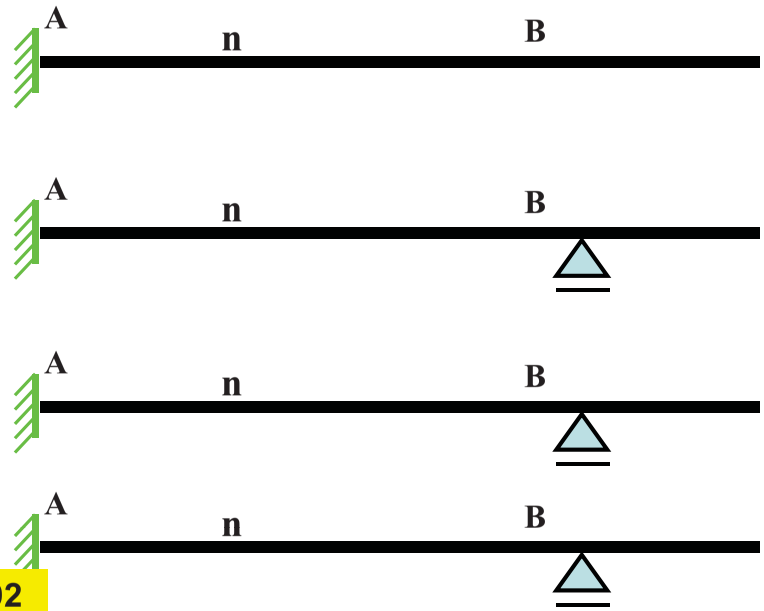
1- y_a , y_b and y_c
2- Q_n and Q_{bR}
3- M_n , M_a and M_b



الجزء **CE** عبارة عن جزء **determinate**
يمكن الرسم عليه قبل الحل

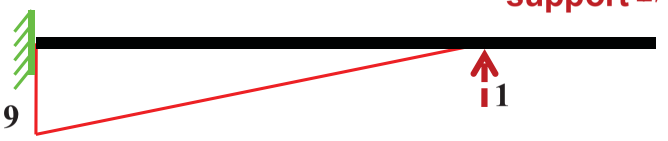


Indeterminate Part

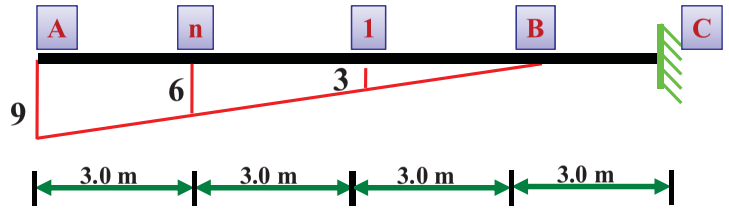


1- يتم عمل main system
بازالة المجهول الزياده.

2- يتم وضع 1 ton مكان الـ support
الذى تم ازالته ورسم العزم



3- يتم تحويل الكمرة الى conjugate beam وعمل تقسيم للكمرة الى
اجزاء متساوية وحساب العزوم عند هذة الاقسام.



293

$M_A = 0.0$

$M_n = -6*3*1.5 - 0.5*3*3*1 = -31.5$

$M_1 = -3*6*3 - 0.5*6*6*2 = -72$

$M_B = -0.5*9*9*3 = -121.5$

$M_C = -0.5*9*9*6 = -243$

يتم قسمة على MB

$\delta_A = 0.00$

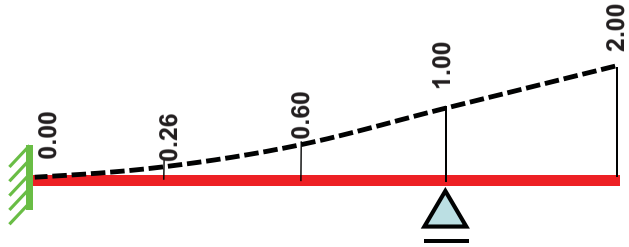
$\delta_n = 0.26$

$\delta_1 = 0.60$

$\delta_B = 1.00$

$\delta_c = 2.00$

ILY_B

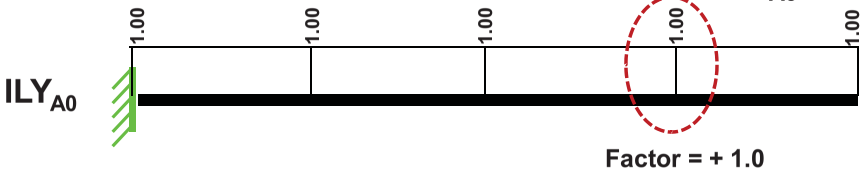


294

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

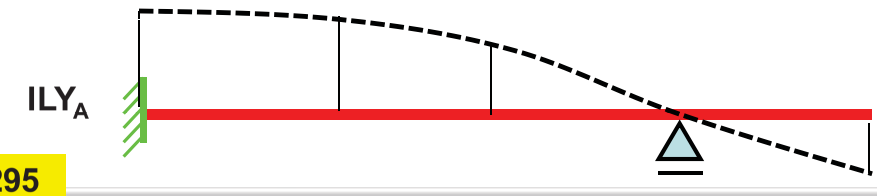
$I.L.Y_A$

1- يتم رسم ILY_{A0} على الكمرة الـ Main system



$I.L.Y_A = I.L.Y_{A0} - factor * I.L.Y_B$

$= I.L.Y_{A0} - 1.0 * I.L.Y_B$

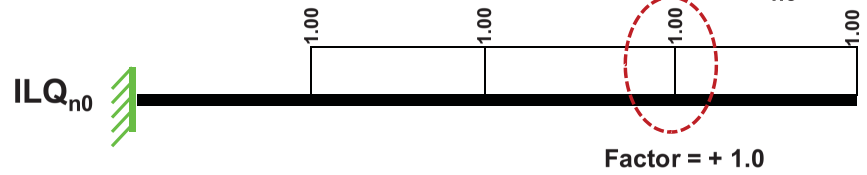


295

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

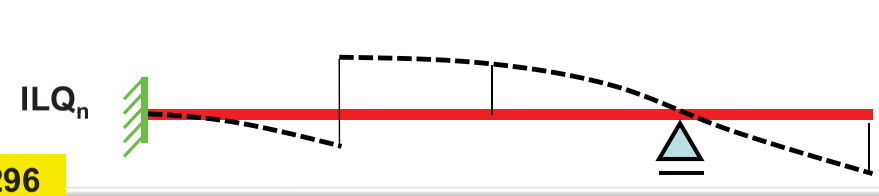
$I.L.Q_n$

2- يتم رسم ILQ_{n0} على الكمرة الـ Main system



$I.L.Q_n = I.L.Q_{n0} - factor * I.L.Y_B$

$= I.L.Q_{n0} - 1.0 * I.L.Y_B$

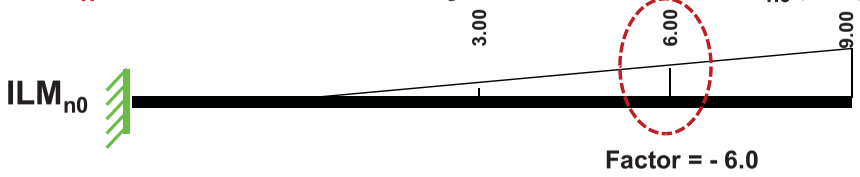


296

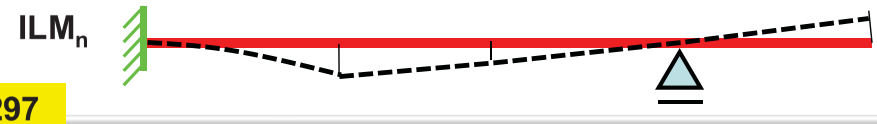
لحساب المطاليب الباقية يتم اجراء نفس الخطوات

I.L.M_n

3- يتم رسم ILM_{n0} على الكمرة الـ Main system



$$I.L.M_n = I.L.M_{n0} - factor * I.L.Y_B$$
$$= I.L.M_{n0} + 6.0 * I.L.Y_B$$



297

لحساب المطاليب الباقية يتم اجراء نفس الخطوات

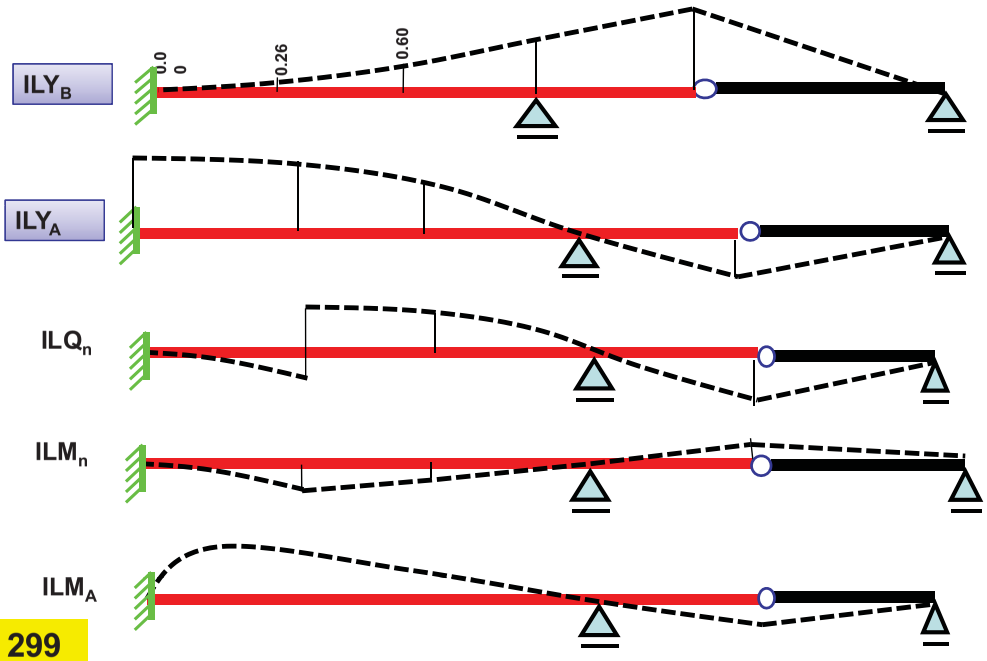
I.L.M_A

4- يتم رسم ILM_{A0} على الكمرة الـ Main system

$$I.L.M_A = I.L.M_{A0} - factor * I.L.Y_B$$
$$= I.L.M_{A0} + 9.0 * I.L.Y_B$$

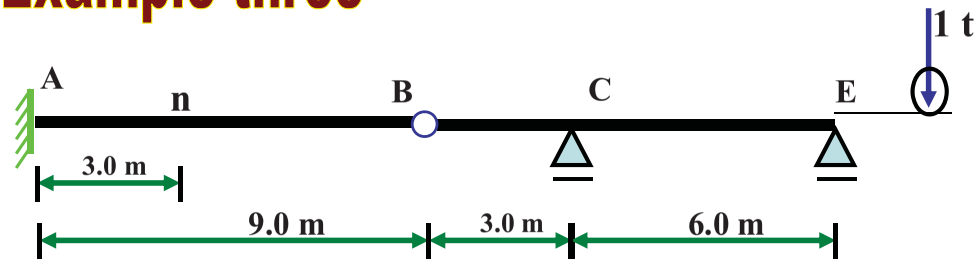
298

خطوة اخيرة يتم مد الـ influnce line على الجزء المحمول (determinate) على كل المطاليب



299

Example three



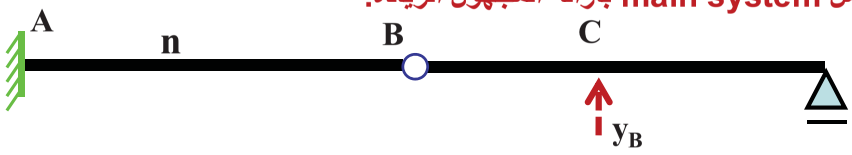
Draw the influence lines for:

1- y_a , y_b and y_c
2- Q_n and Q_{bR}
3- M_n , M_a and M_b

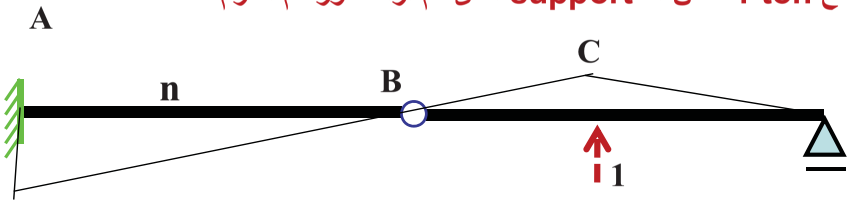
300

المثال هنا غير المثال السابق لانه لايوجد به جزء Determinate كما بالسابق

1- يتم عمل main system بازالة المجهول الزياده.



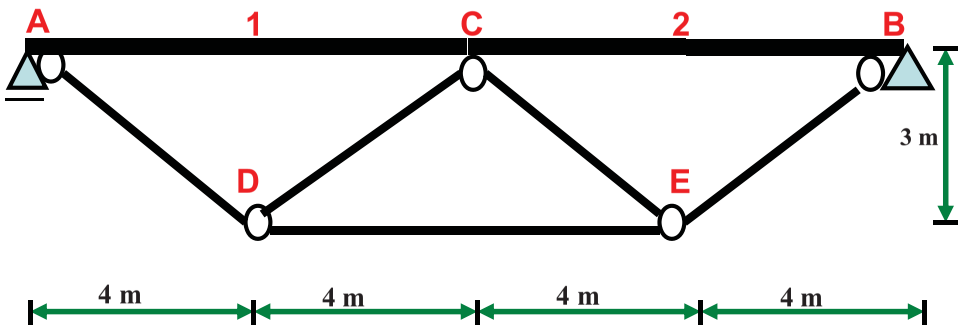
2- يتم وضع 1 ton مكان الـ support الذى تم ازالته ورسم العزم



بسم الله الرحمن الرحيم

Trussed Beam

Example one



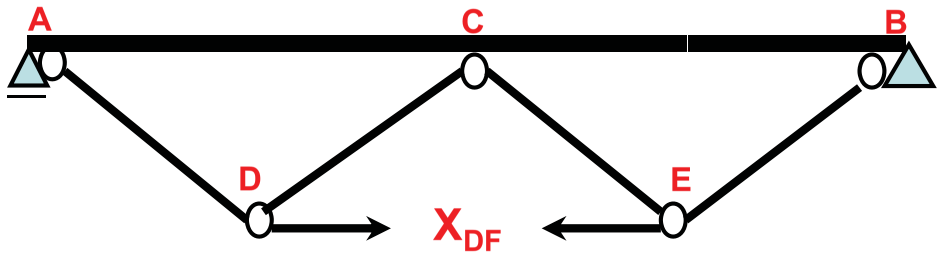
Draw the influence lines for:

1- X_{DE} and y_A

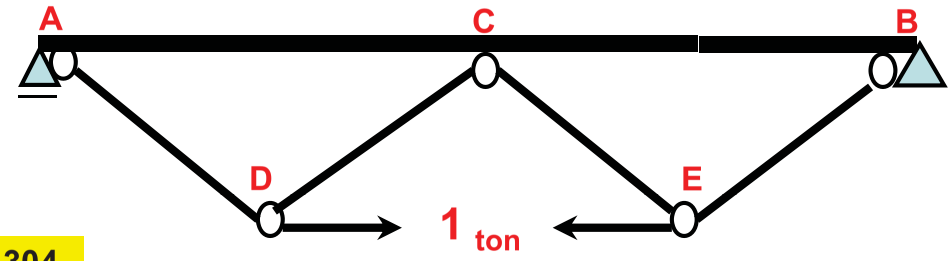
2- Q_1 , Q_{cR} and M_1

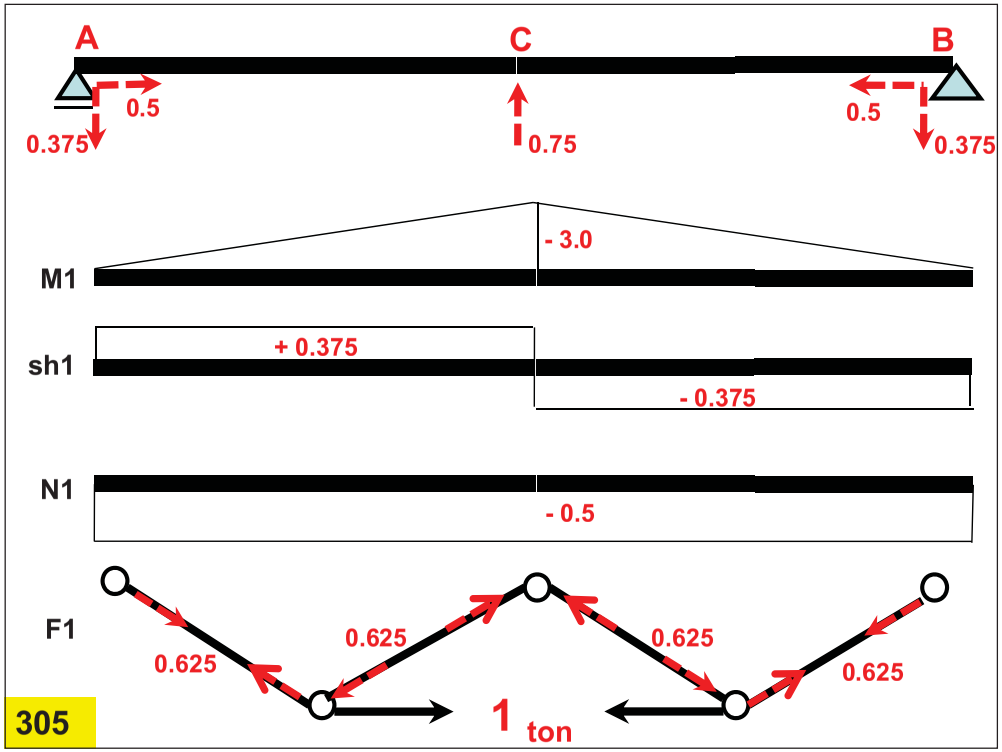
EI_{beam}=6000 ton EA_{beam}=2400 ton EA_{link}=4000 ton

1- يتم عمل main system بازالة المجهول الزياده.



2- يتم وضع 1 ton مكان الـ normal الذى تم ازالته ورسم العزم والـ normal





305

$$\delta_{11} = \int \frac{M1 * M1}{EI} + \int \frac{N1 * N1}{EA} + \int \frac{F1 * F1}{EA}$$

$$\delta_{11} = \frac{1}{6000}\left[\frac{3 * 3 * 8}{3} * 2\right] + \frac{1}{2400}\left[0.5 * 0.5 * 16\right]$$

$$+ \frac{1}{4000}\left[1 * 1 * 8 + 4 * 0.625 * 0.625 * 5\right] = 0.0082$$

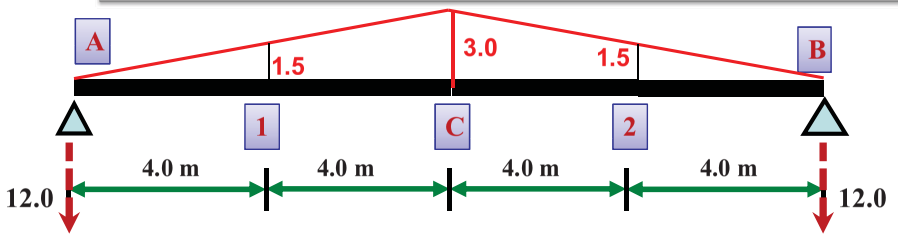
$$X * \delta_{11} = 1.0$$

$$X = \frac{1}{\delta_{11}} = 120$$

$$\delta_{11} = \frac{X}{EI} * Mi = \frac{120}{6000} * Mi = 0.02\ Mi$$

306

3- يتم تحويل الكمرة الى conjugate beam



$\delta_A = 0.02*(0.0) = 0.0$

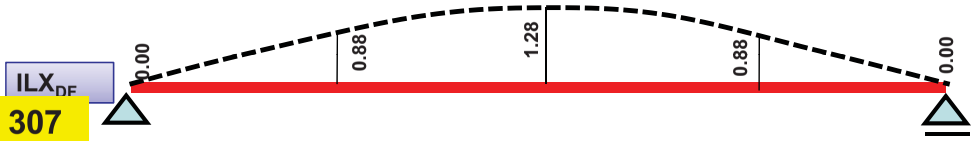
$\delta_1 = 0.02*(-12*4+0.5*1.5*4*4/3) = -0.88$

$\delta_C = 0.02*(-12*8+0.5*3.0*8*8/3) = -1.28$

$\delta_2 = 0.02*(-12*4+0.5*1.5*4*4/3) = -0.88$

$\delta_B = 0.02*(0.0) = 0.0$

δ سالبه ترسم فوق الخط
موجبة ترسم تحت الخط



307

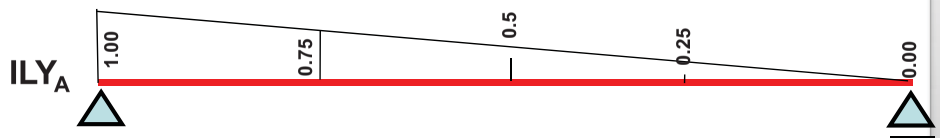
لحساب المطاليب الباقية يتم اجراء نفس الخطوات

فى مسائل الـ trussed beam يتم الحصول على الـ factor من رسومات الـ M1 و sh1 و N1 على حسب المطلوب

Factor	for	YA	= 0.0
Factor	for	Qn	= +0.375
Factor	for	Mn	= -1.5
Factor	for	Qcr	= -0.375

I.L.Y_A

1- يتم رسم ILY_{A0} على الكمرة الـ Main system



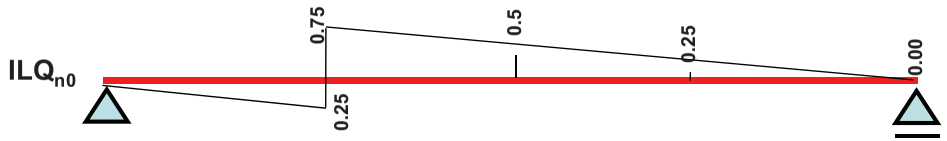
$I.L.Y_A = I.L.Y_{A0} + 0.0 * I.L.X_{DF}$

$= I.L.Y_{A0}$

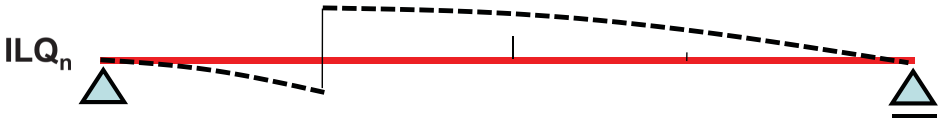
308

$I.L.Q_n$

2- يتم رسم ILQ_{n0} على الكمرة الـ Main system

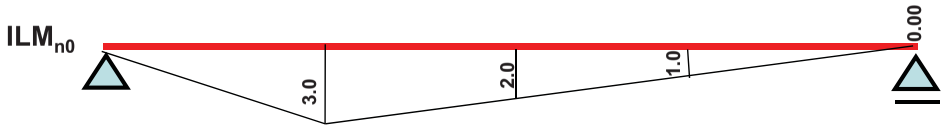


$$I.L.Q_n = I.L.Q_{n0} + 0.375 * I.L.X_{DF}$$



$I.L.M_n$

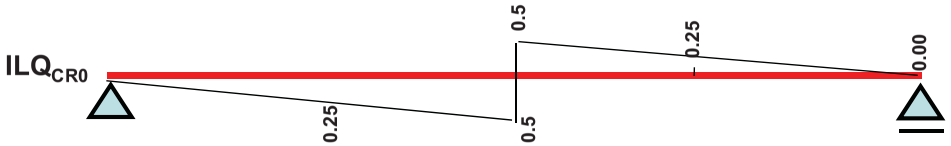
3- يتم رسم ILM_{n0} على الكمرة الـ Main system



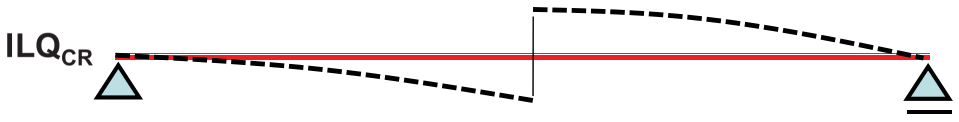
$$I.L.M_n = I.L.M_{n0} - 1.5 * I.L.X_{DF}$$

$I.L.Q_{CR}$

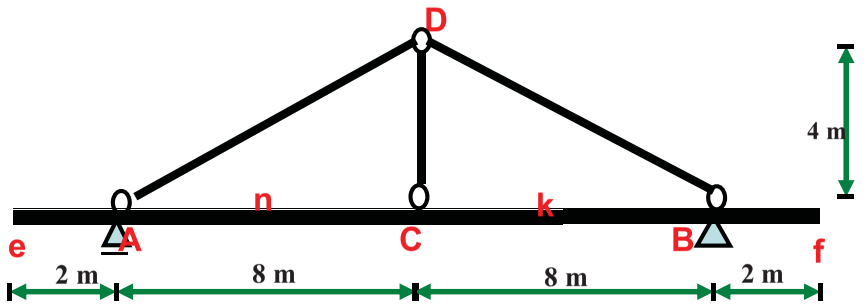
4- يتم رسم ILQ_{CR0} على الكمرة الـ Main system



$$I.L.Q_{CR} = I.L.Q_{CR0} - 0.375 * I.L.X_{DF}$$



Example TWO

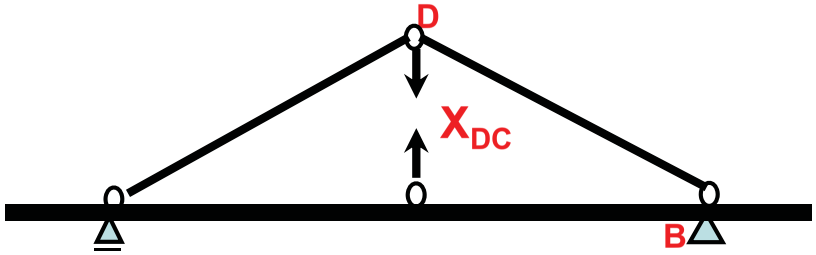


Draw the influence lines for:

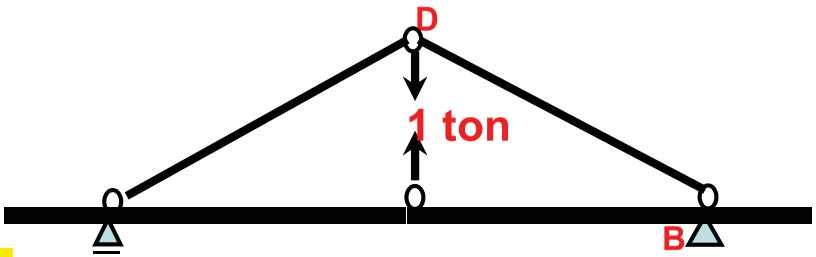
1- X_{DC} and y_A

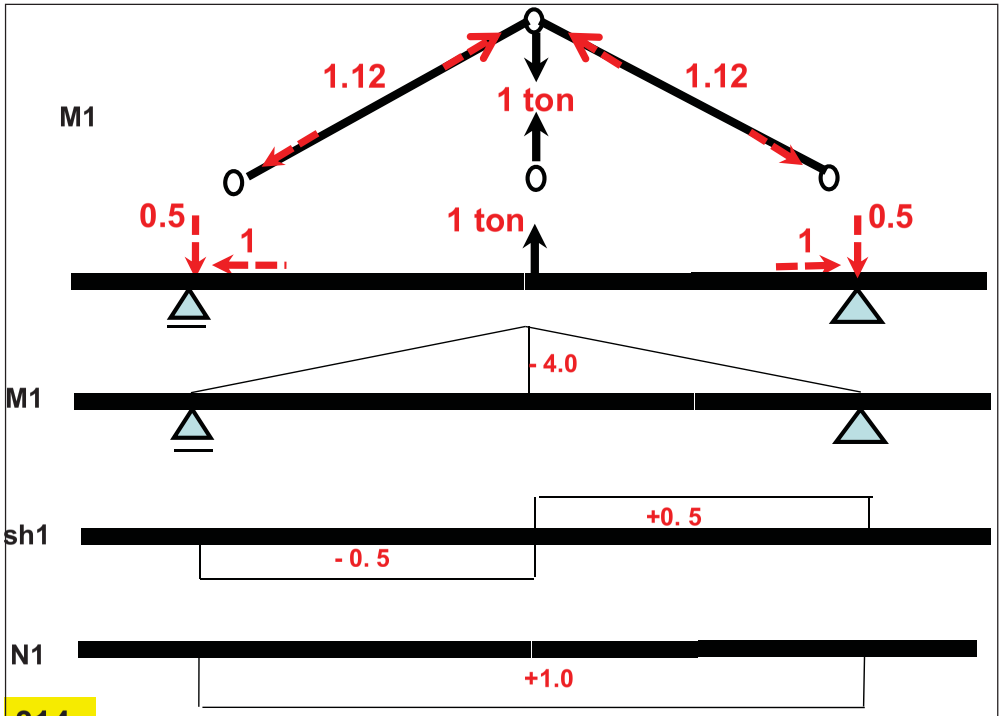
2- Q_n , Q_{cR} and M_n

1- يتم عمل main system بازالة المجهول الزياده.



2- يتم وضع 1 ton مكان الـ normal الذى تم ازالته ورسم العزم والـ normal





$$\delta_{11} = \int \frac{M1 * M1}{EI} + \int \frac{N1 * N1}{EA} + \int \frac{F1 * F1}{EA}$$

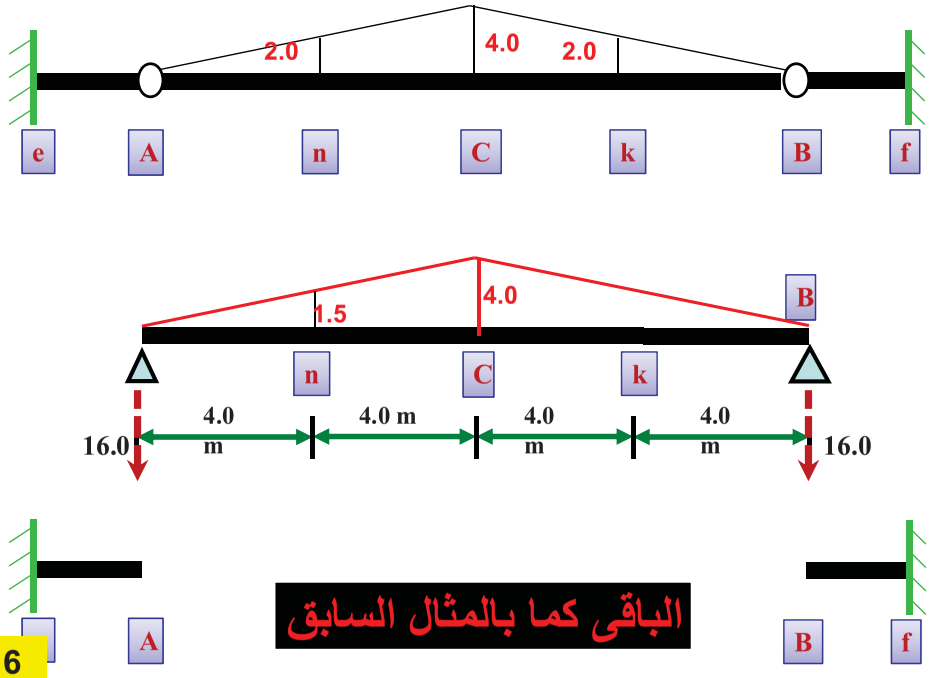
$\delta_{11} =$ كما بالمثال السابق

$$X * \delta_{11} = 1.0$$

$$X = \frac{1}{\delta_{11}}$$

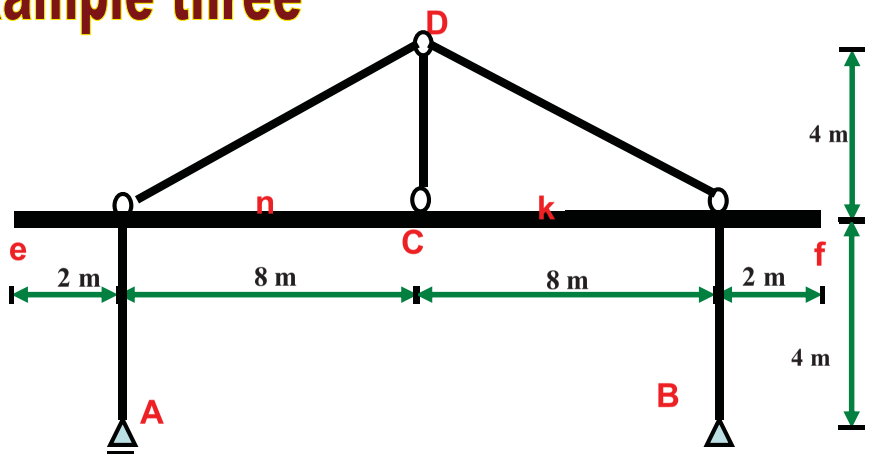
$$\delta_{11} = \frac{X}{EI} * Mi$$

3- يتم تحويل الكمرة الى conjugate beam



الباقى كما بالمثال السابق

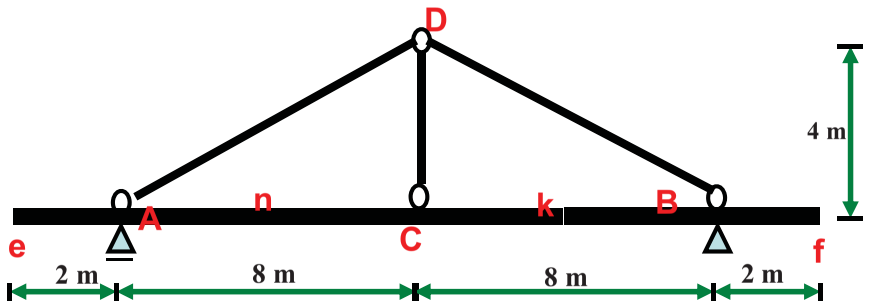
Example three



Draw the influence lines for:

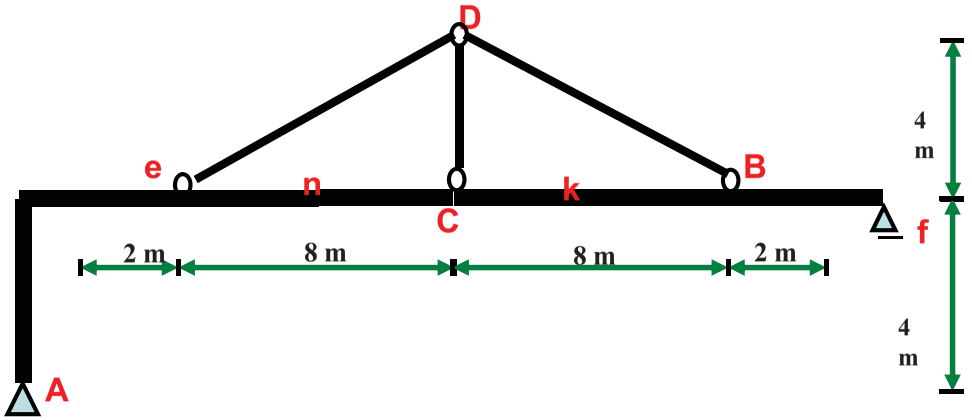
1- X_{DC} and y_A

2- Q_n , Q_{cR} and M_n



يتم رفع الـ supports الى اعلى لانه لا يوجد فى الـ influence line احمال افقية وبالتالى لا يوجد على الاعمده عزوم (يستثنى من ذلك اذا كانت fixed) يتم اعتبار المسأله cantilivar

Example four



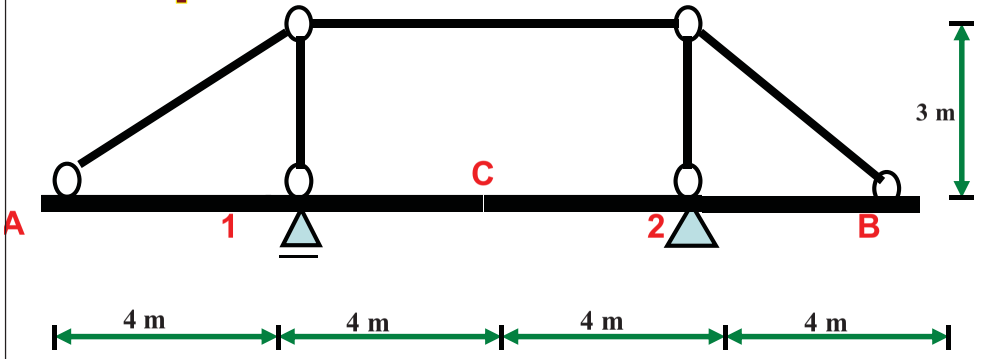
Draw the influence lines for:

1- X_{DC} and y_A

2- Q_n , Q_{cR} and M_n

EI_{beam}=6000 ton EA_{beam}=2400 ton EA_{link}=4000 ton

Example five



Draw the influence lines for:

1- X_{DE} and y_A

2- Q_1 , Q_{cR} and M_1

EI_{beam}=6000 ton EA_{beam}=2400 ton EA_{link}=4000 ton

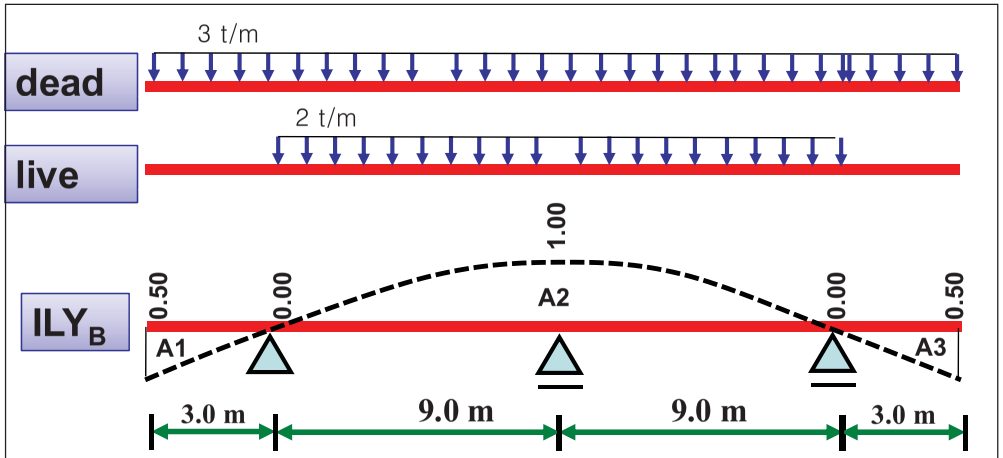
مهمة جدا

مطلوب اخر فى مسائل الـ influence line هو

Find the maximum values of Y or Q or M due to 2t/m live load and 3 t/m dead load

1- يتم وضع الاحمال الميته على كافة الكمرة (موجب و سالب)
2- يتم وضع الاحمال الحية على الجزء الاكبر سواء كان موجب او سالب (احدهما فقط)
3- حساب المساحات تقريبة من الرسم وضربها فى الحمل المقابل لها

المساحات تقريبة
1- مستطيل (a * b)
1- مثلث (1/2 a * b)
1- محدب (2/3 a * b)
1- مقعر (1/3 a * b)



A1 = 0.5*0.5*3 = _ 0.75
A2 = 2/3 *1.0* 18 = + 12.0
A1 = 0.5*0.5*3 = _ 0.75

$Y_{Bma\ x}$ = 3.0 * (- 0.75 + 12 - 0.75)+ 2*(12) = 55.5 ton

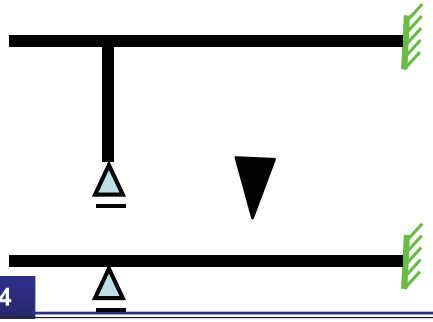
بســـم اللـــــه الرحمـــن الرحيـــم

Influence line

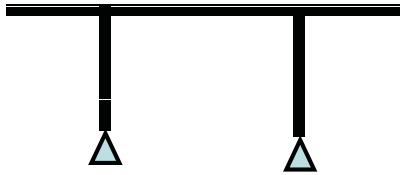
Frames

هناك نوعين للـ frames

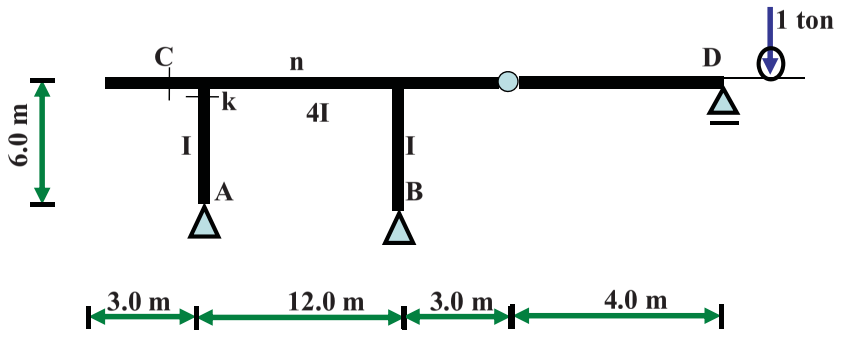
النوع الاول
يمكن تحويل الـ frame الى beam
وتحل مثل الـ beam



النوع الثانى
لا يمكن تحويل الـ frame الى beam
وتحل مثل الـ trussed beam



Example one



Draw the influence lines for:

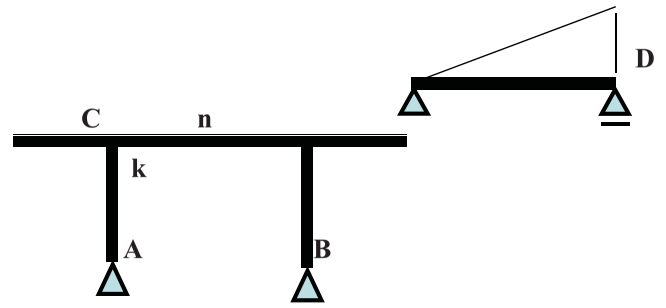
1- X_A and M_n

2- M_k , N_k and Q_k

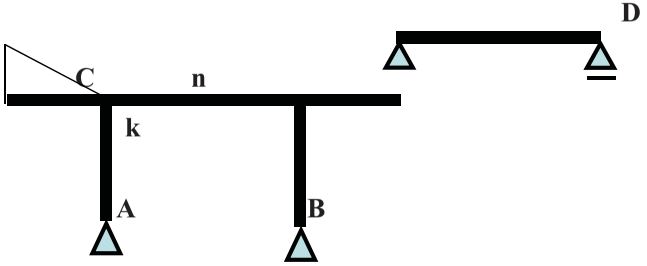
3- M_C and Y_D

EI_{beam}=6000 ton

I.L.Y_D



I.L.M_C

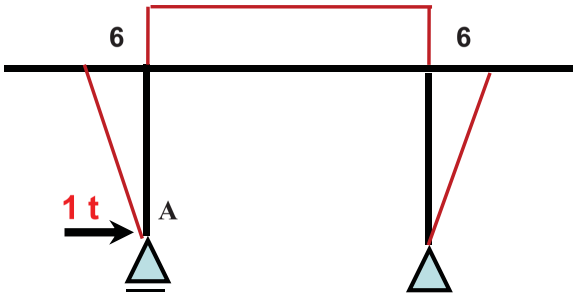


326

1- يتم عمل main system بازالة المجهول الزياده.

2- يتم وضع 1 ton مكان الـ normal الذى تم ازالته ورسم العزم والـ normal

M1



$$\delta_{11} = \int \frac{M1 * M1}{EI}$$

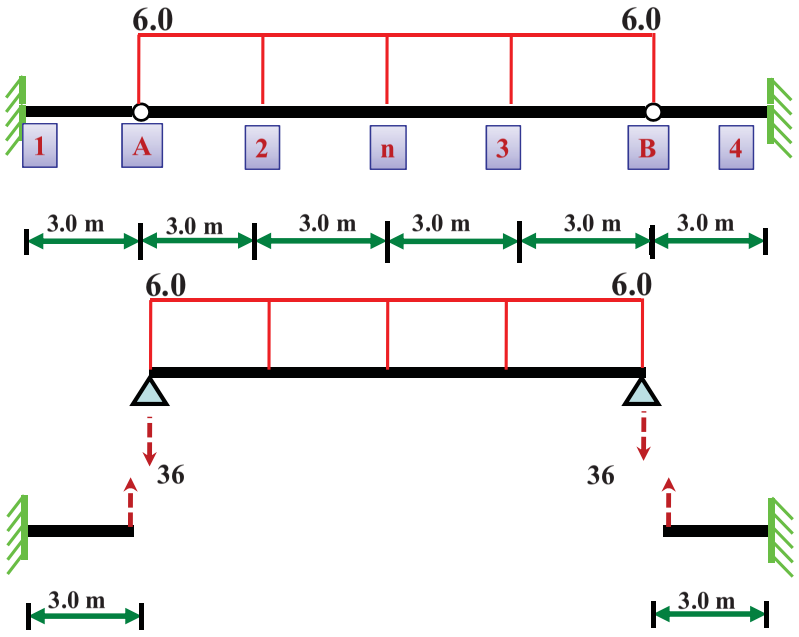
$$\delta_{11} = \frac{1}{6000}\left[\frac{6*6*6}{3}*2\right] + \frac{1}{6000*4}\left[6*6*12\right] = 0.042$$

$$X * \delta_{11} = 1.0$$

$$X = \frac{1}{\delta_{11}} = 23.8$$

$$\delta_{11} = \frac{X}{EI} * Mi = \frac{23.8}{6000*4} * Mi = 0.001\ Mi$$

4 - يتم عمل تقسيم للكمرة الى اجزاء متساوية وحساب العزوم عند هذة الاقسام.



$\delta_1 = 0.001*(36*3) = 0.108$

$\delta_A = 0.001*(0.0) = 0.0$

$\delta_2 = 0.001*(-36*3 - 6*3*1.5) = -0.135$

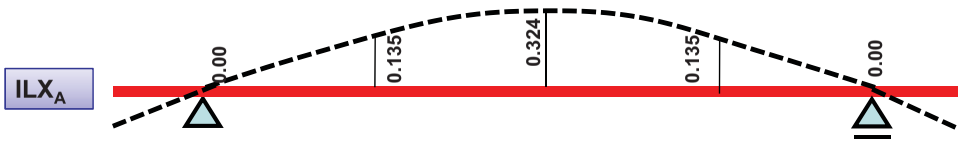
$\delta_n = 0.001*(-36*6 - 6*6*3) = -0.324$

$\delta_3 = -0.135$

$\delta_B = 0.0$

$\delta_4 = 0.108$

δ سالبه ترسم فوق الخط
موجبة ترسم تحت الخط

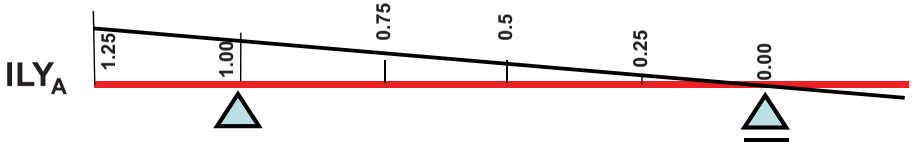


لحساب المطاليب الباقية يتم اجراء نفس الخطوات

Factor	for	YA	= 0.0
Factor	for	Mk	= - 6*XA
Factor	for	Nk	= - YA
Factor	for	Qk	= - XA
Factor	for	Qn	= 0.0
Factor	for	Mn	= - 6

$I.L.Y_A$

1- يتم رسم ILY_{A0} على الكمرة الـ Main system

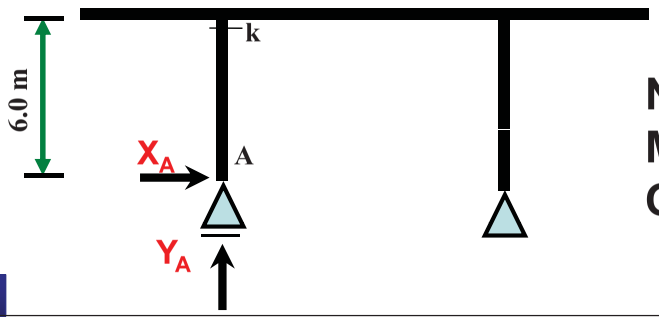


$I.L.Y_A = I.L.Y_{A0} + 0.0 * I.L.X_{DF}$

$= I.L.Y_{A0}$

المطلوب M_K, N_K, Q_K

يتم ضرب الشكل الاول I.L.XA فى القيم التى تم حسابها فى الصفحة السابقة



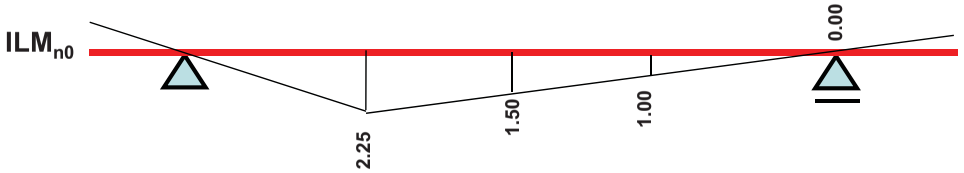
$N_k = -YA$

$M_K = 6* XA$

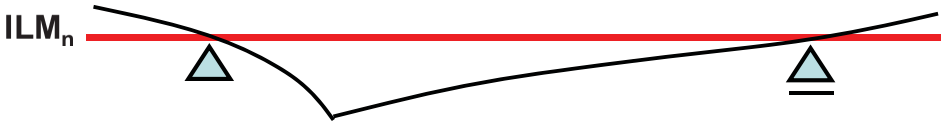
$Q_K = XA$

$I.L.M_n$

3- يتم رسم ILM_{n0} على الكمرة الـ Main system



$$I.L.M_n = I.L.M_{n0} - (-6.0) * I.L.X_A$$



بســـم اللـــــه الرحمـــن الرحيـــم

Influence line

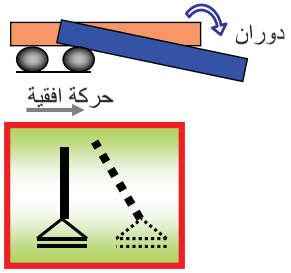
Multistory

بعض الاساسيات الهامه

1- SUPPORTS

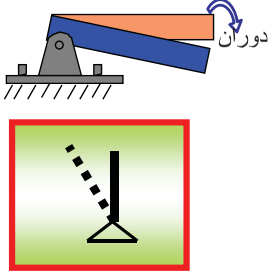
ROLLER SUPPORT

تسمح بالحركة الافقية والدوران



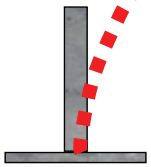
HINGED SUPPORT

تسمح بالدوران فقط

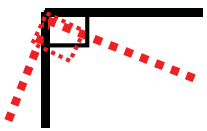


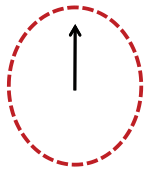
FIXED SUPPORT

لا تسمح بأى حركة

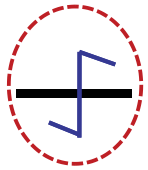


يجب ان تكون الزاويه ثابته قبل وبعد التشكل

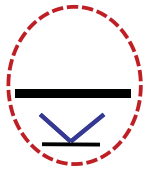




I.L.Y

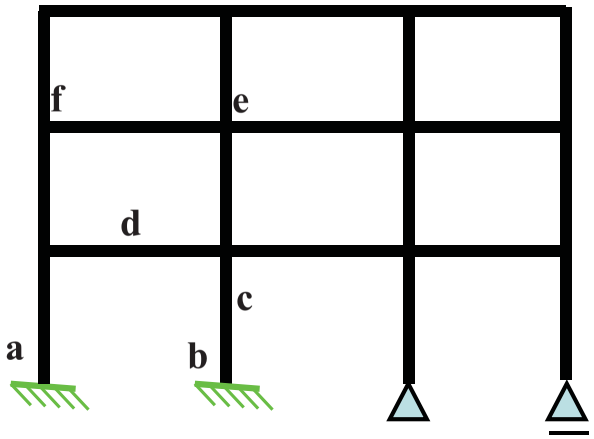


I.L.Q



I.L.M

Example one

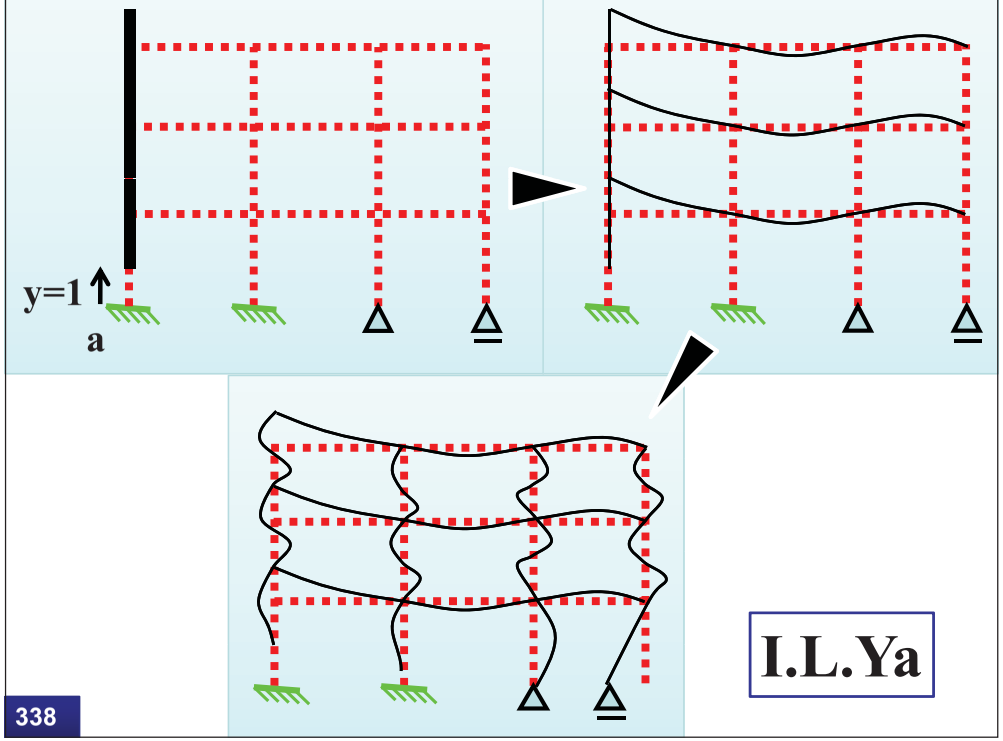


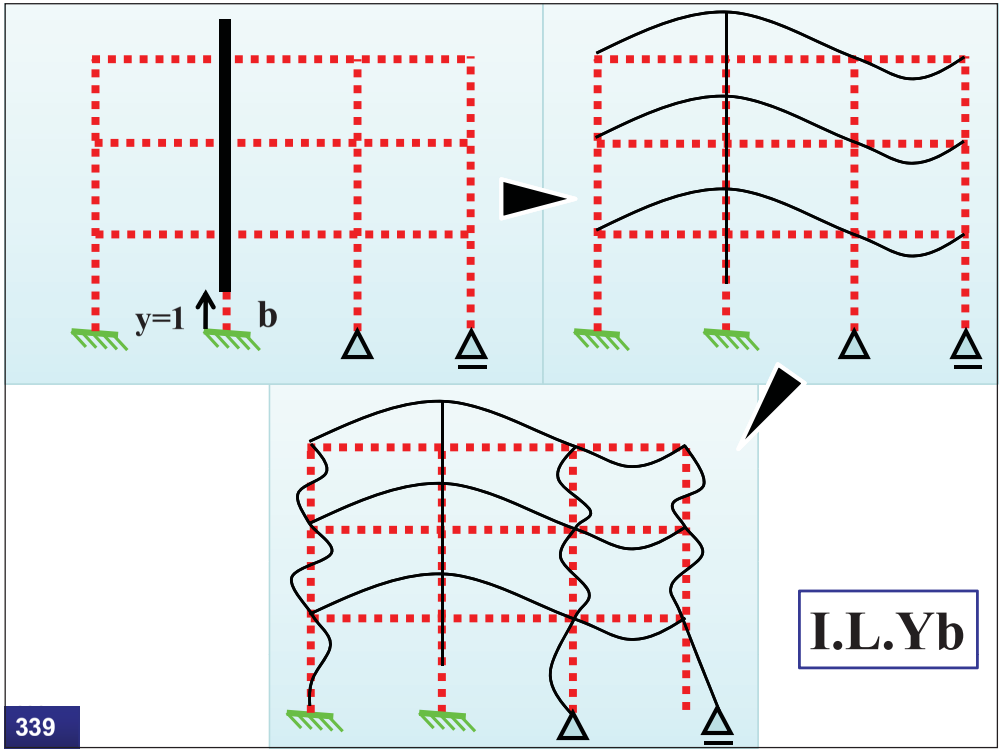
Draw the influence lines for:

1- y_a , y_b and N_c

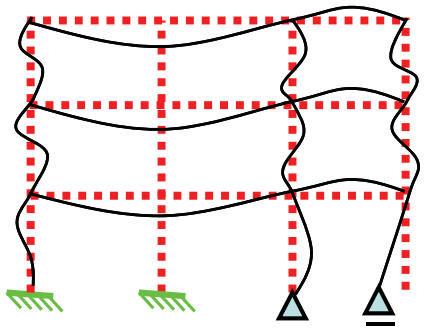
2- Q_d , Q_{eL} and Q_{eR}

3- M_d , M_e and M_f

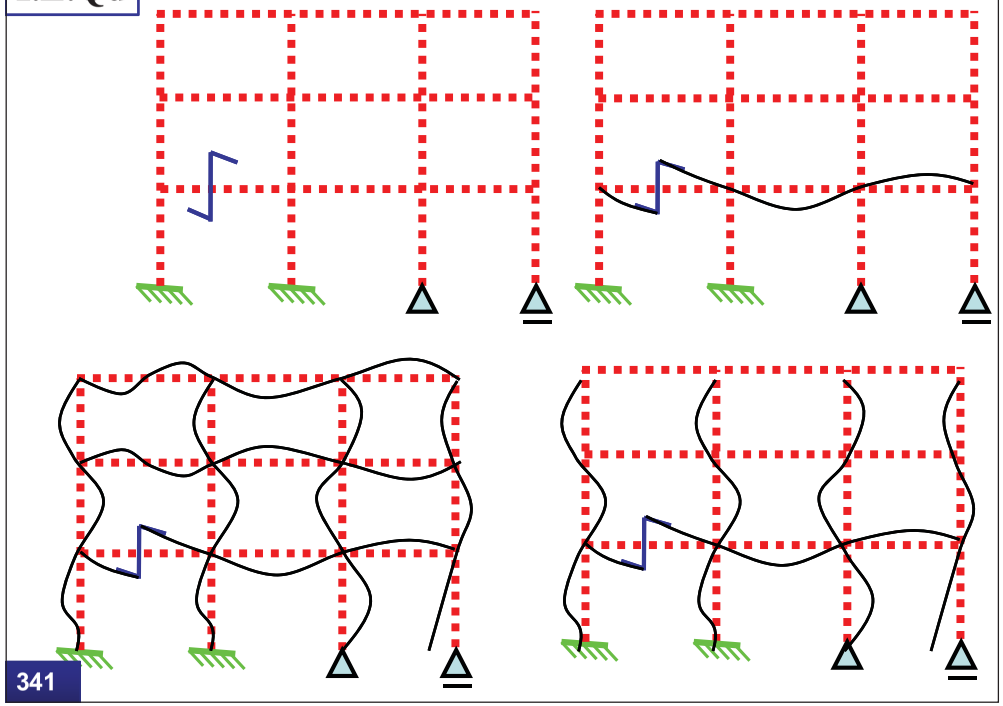




I.L.Nc = − I.L.Yb

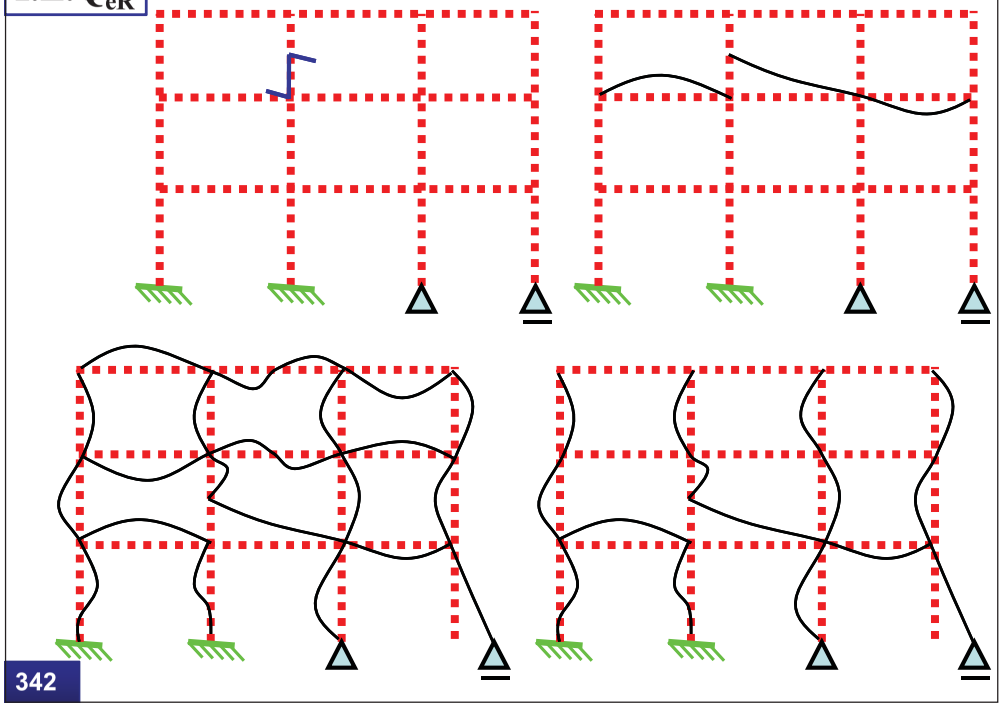


I.L.Qd



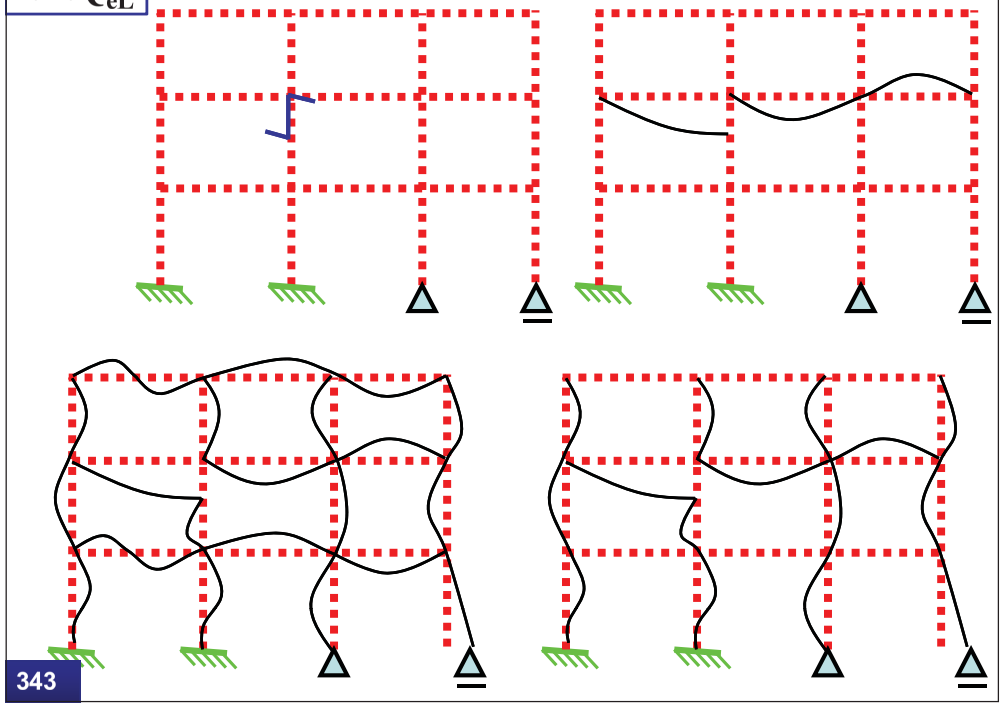
341

I.L.Q_{eR}



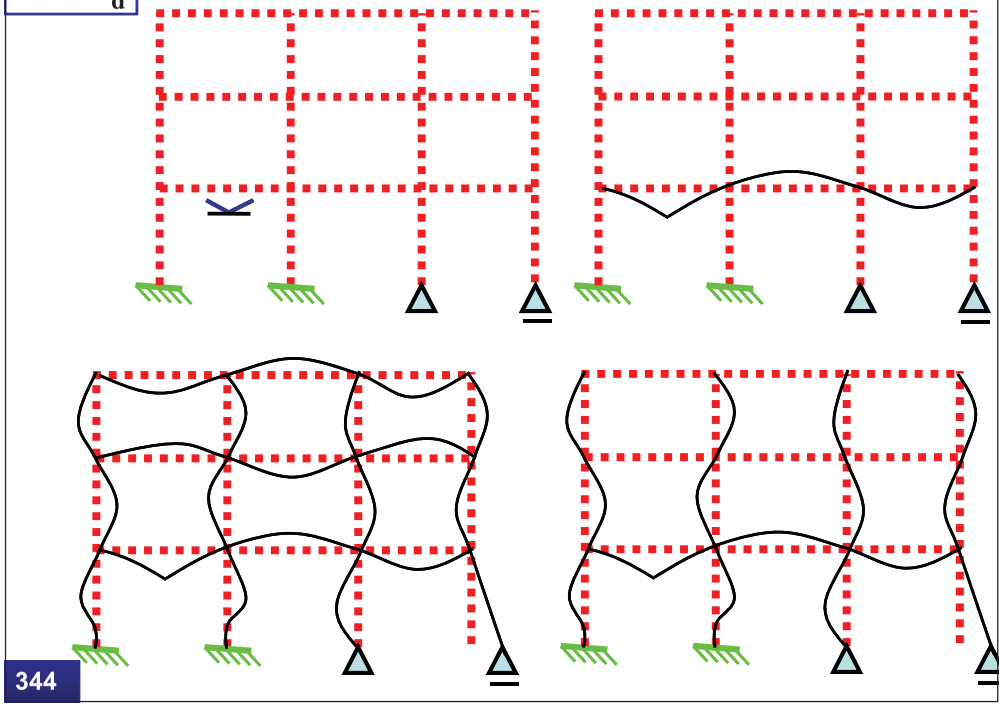
342

I.L.Q_{eL}



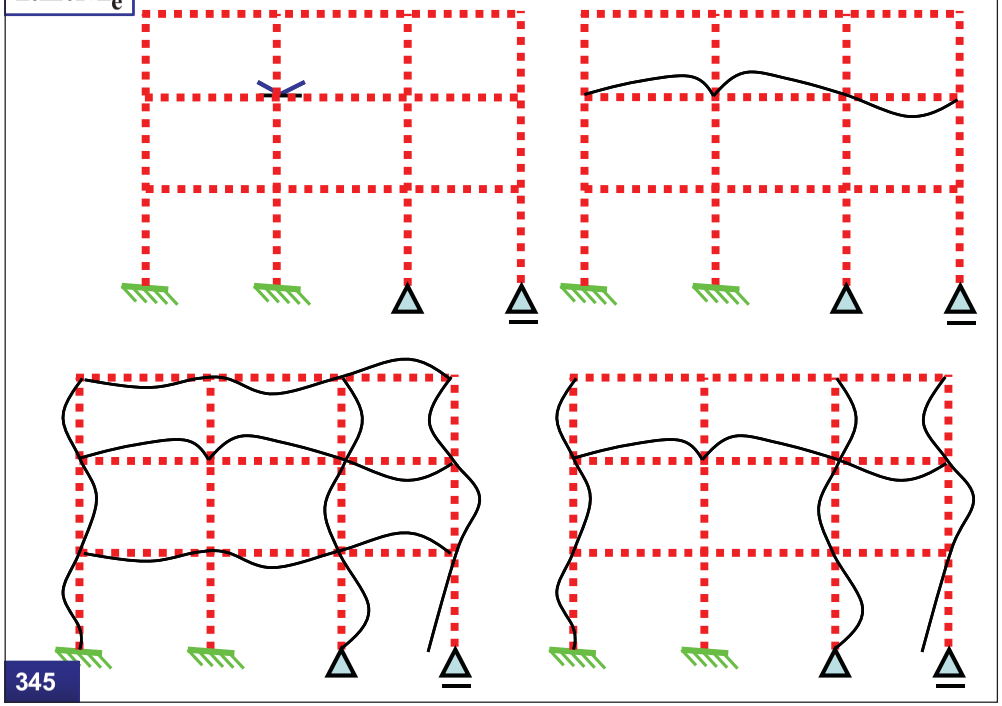
343

I.L.M_d



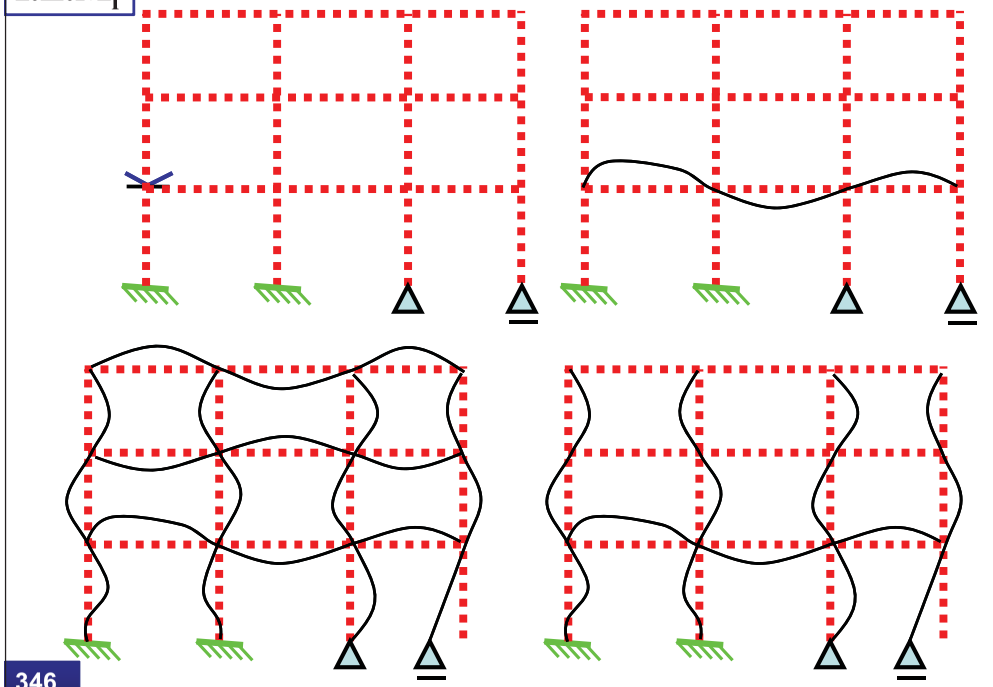
344

I.L.M_e



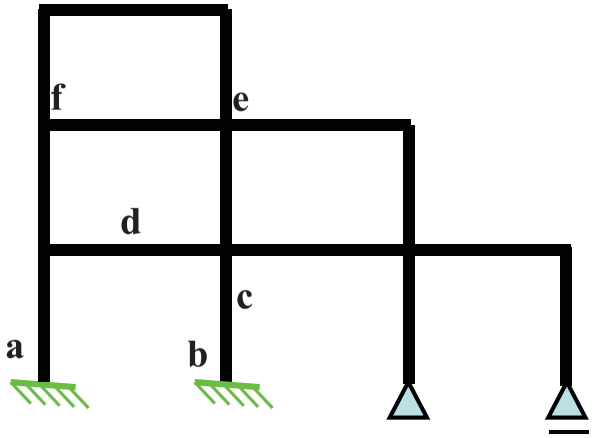
345

I.L.M_f



346

Example two



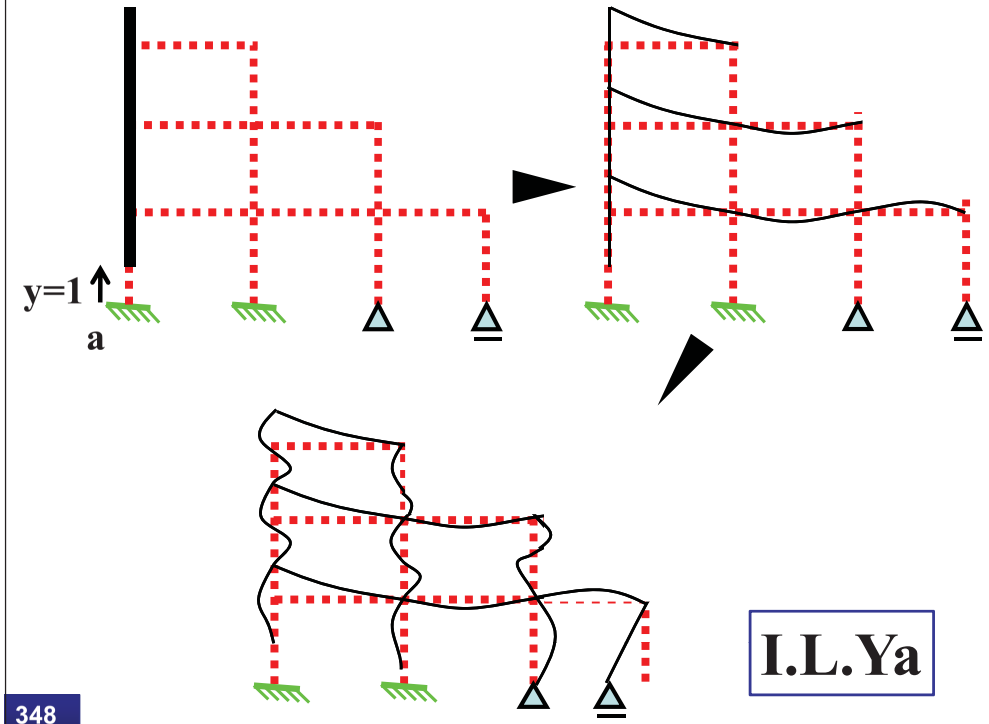
Draw the influence lines for:

1- y_a , y_b and N_c

2- Q_d , Q_{eL} and Q_{eR}

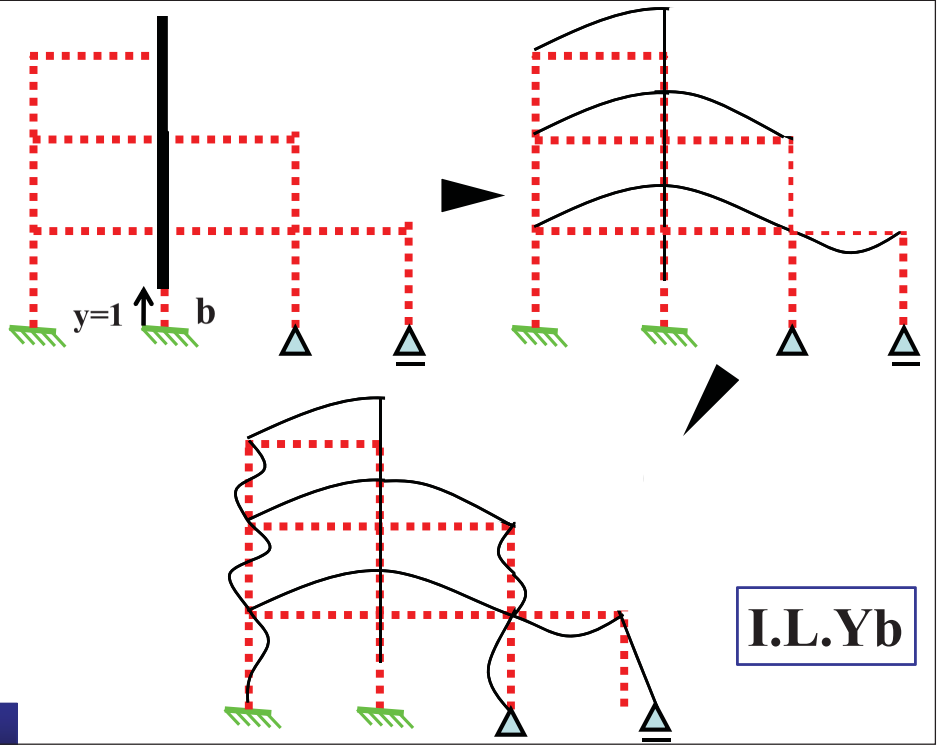
3- M_d , M_e and M_f

347

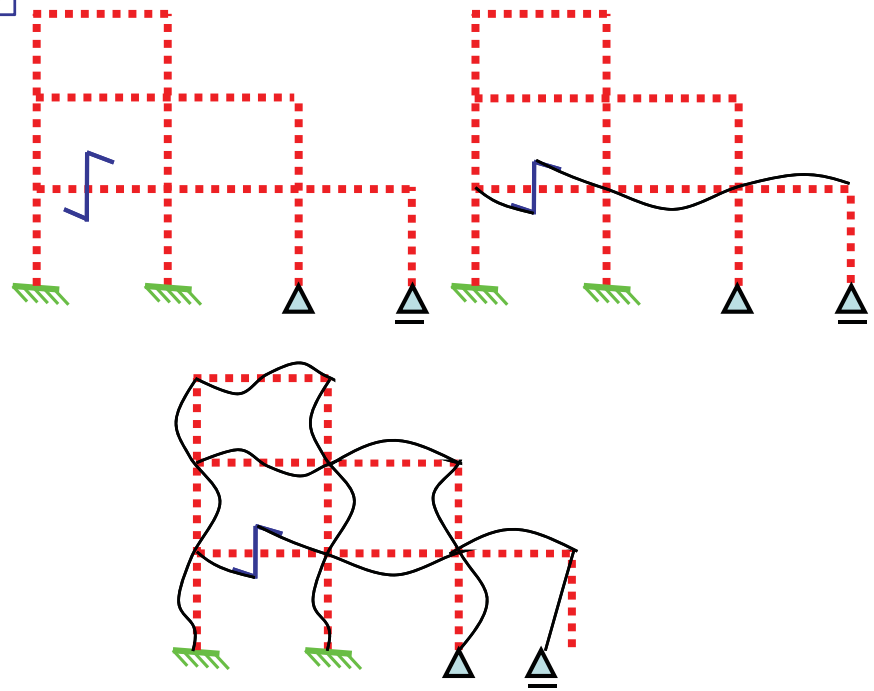


I.L.Ya

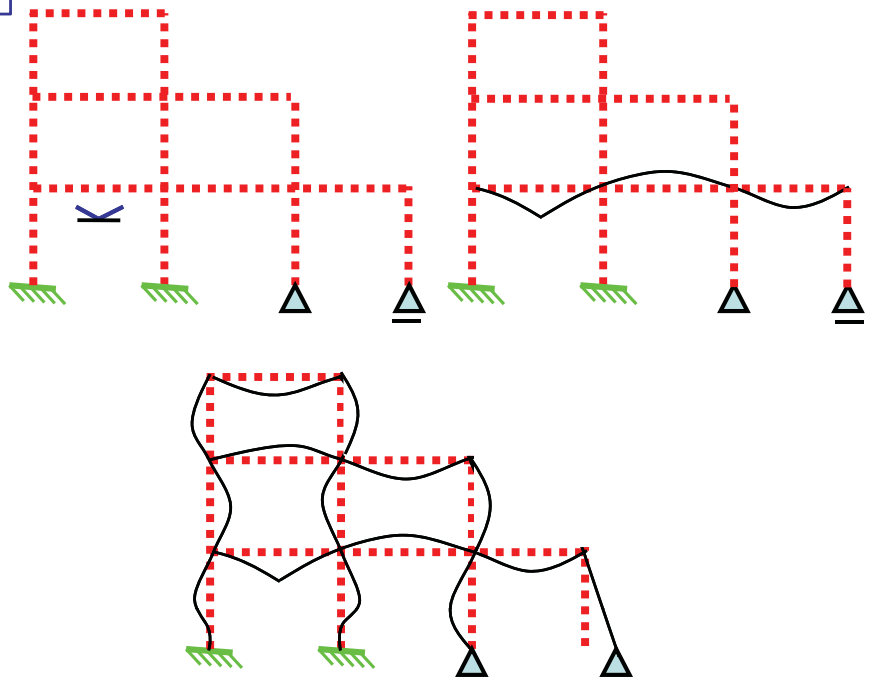
348



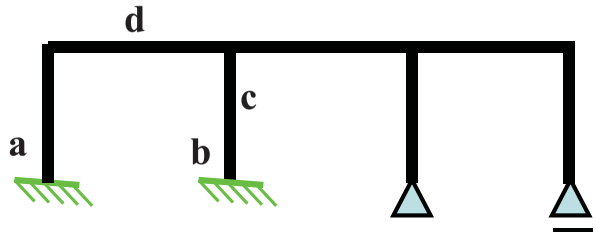
I.L.Qd



I.L.M_d



Example three

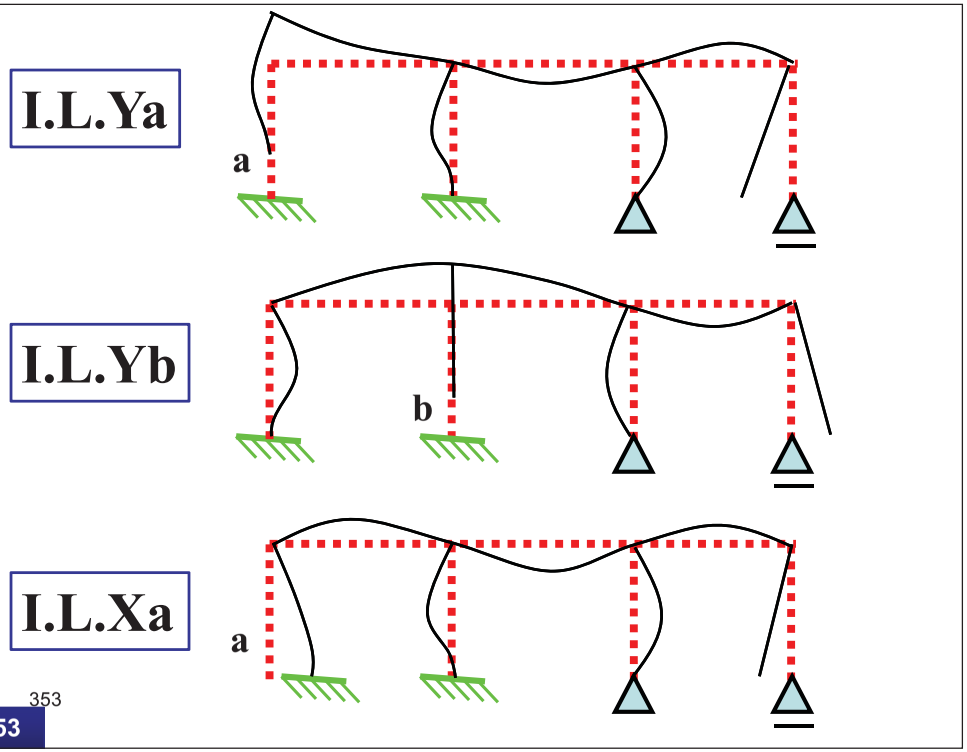


Draw the influence lines for:

1- y_a , y_b and X_c

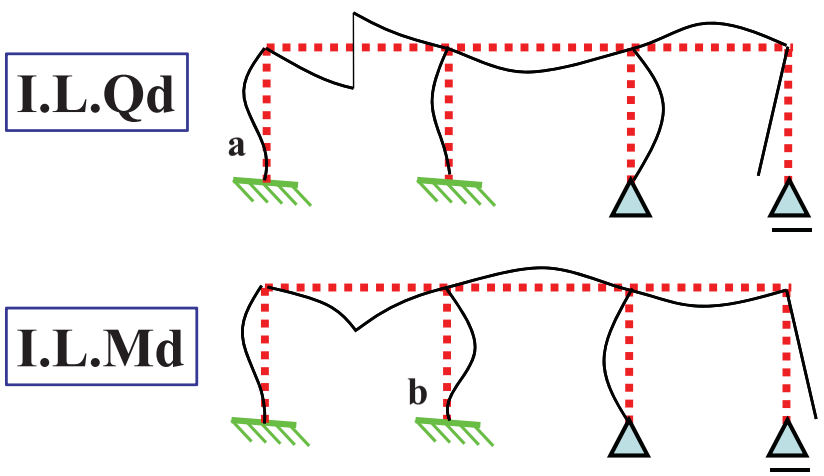
2- Q_d

3- M_d



353

353



354

بسم الله الرحمن الرحيم

Without Calculation

determinate and Indeterminate structure

Eng : Ayman abdo

355

بعض الاساسيات الهامه

1- SUPPORTS

ROLLER SUPPORT

تسمح بالحركة الافقية والدوران

دوران

حركة افقية

HINGED SUPPORT

تسمح بالدوران فقط

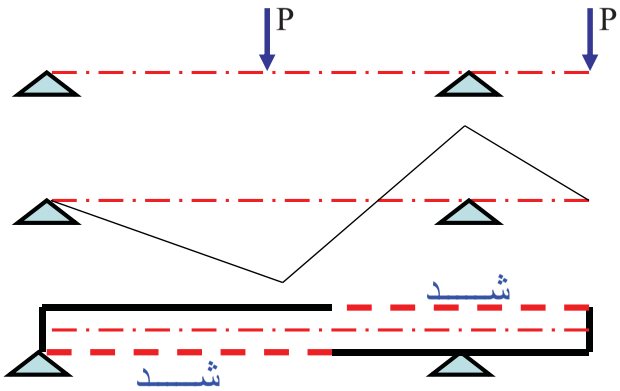
دوران

FIXED SUPPORT

لا تسمح بأى حركة

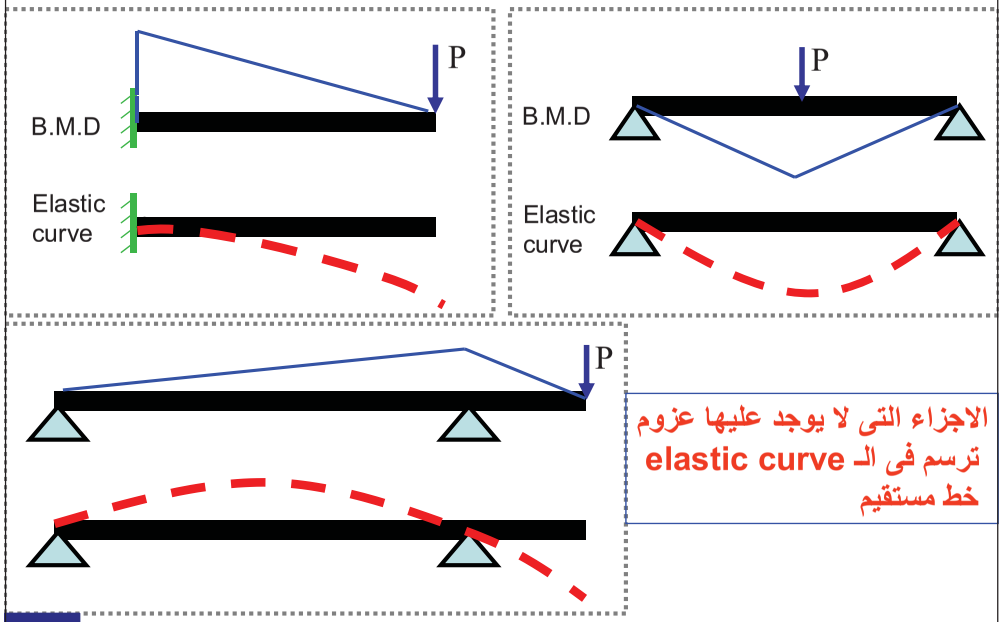
356

1- يكون العزم فى اتجاه الشد



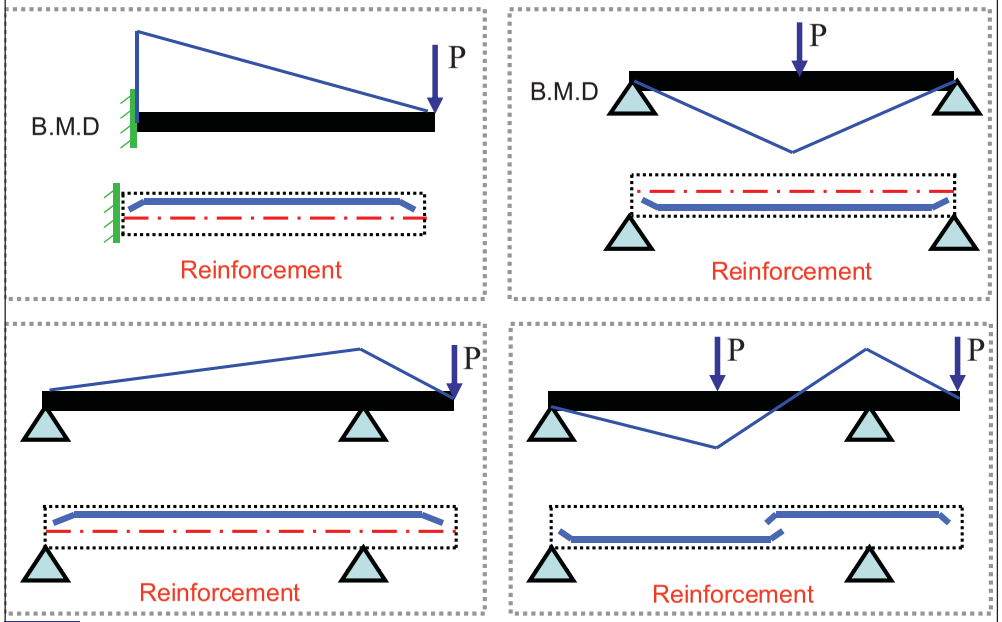
2- يجب ان تكون الزاويه ثابته قبل وبعد التشكل

3- يكون الانحناء محدب ناحية العزم



الاجزاء التى لا يوجد عليها عزوم ترسم فى الـ elastic curve خط مستقيم

4- يكون التسليح ناحية العزم

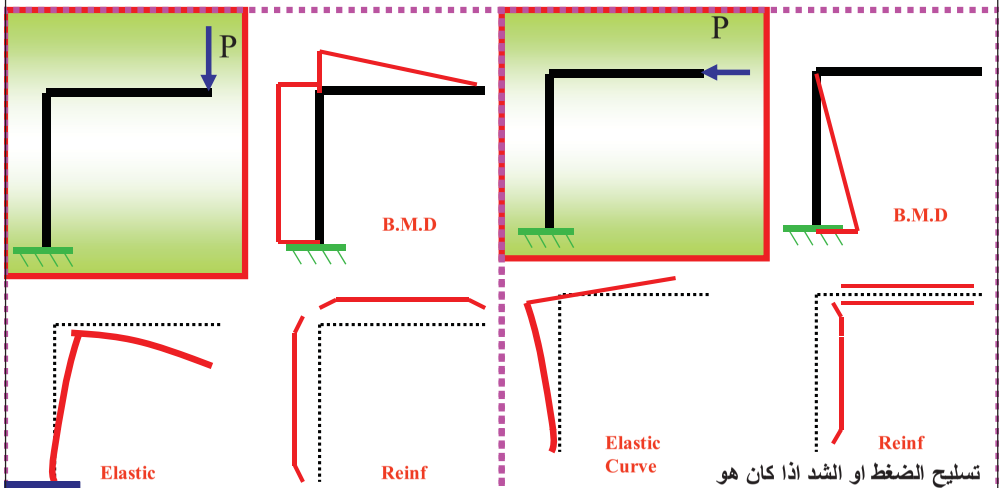


Determinate Structures

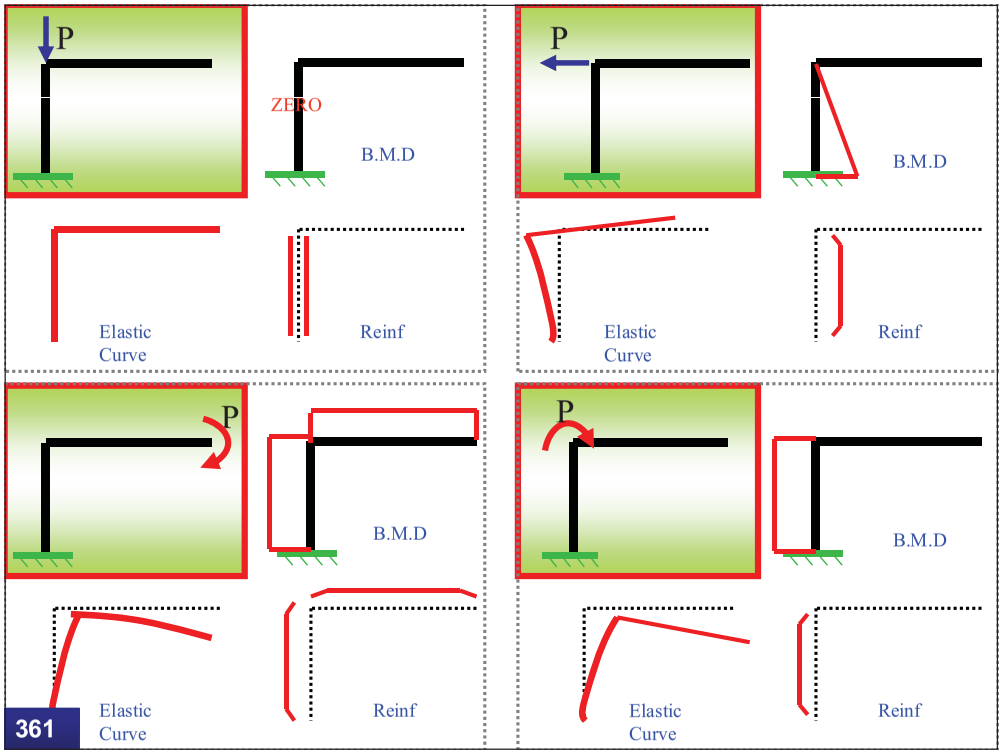
فى هذه المنشآت سيكون من السهل توقع اتجاهات الـ reactions

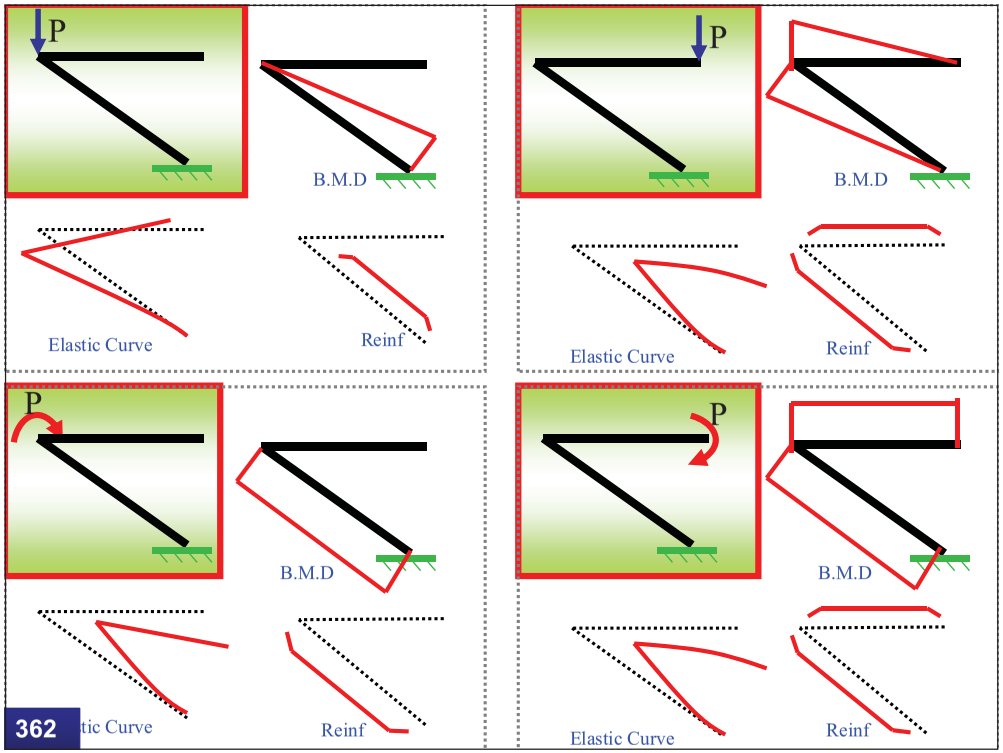
1- رسم العزوم

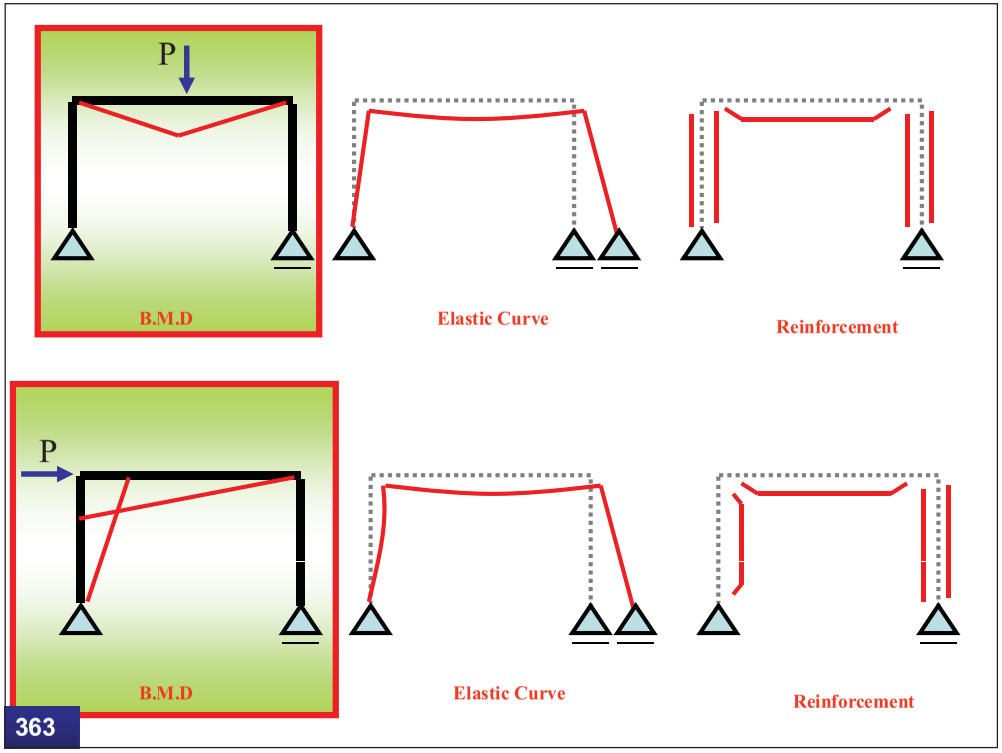
2- يتم تحديد اتجاه التحديب حسب شكل العزم واماكن التسليح

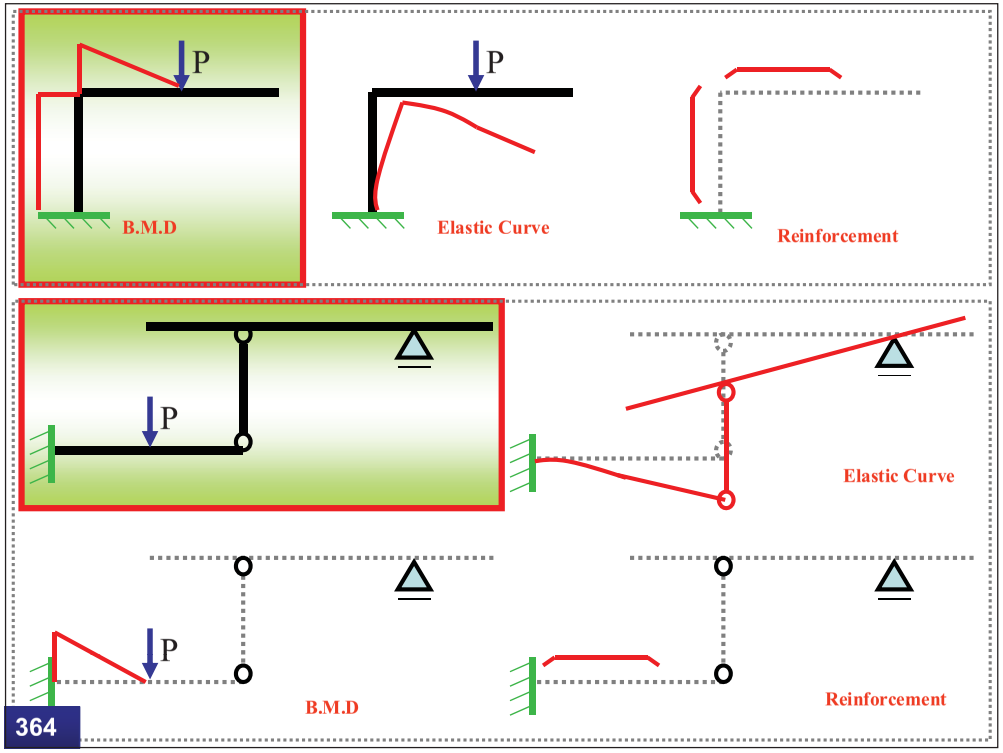


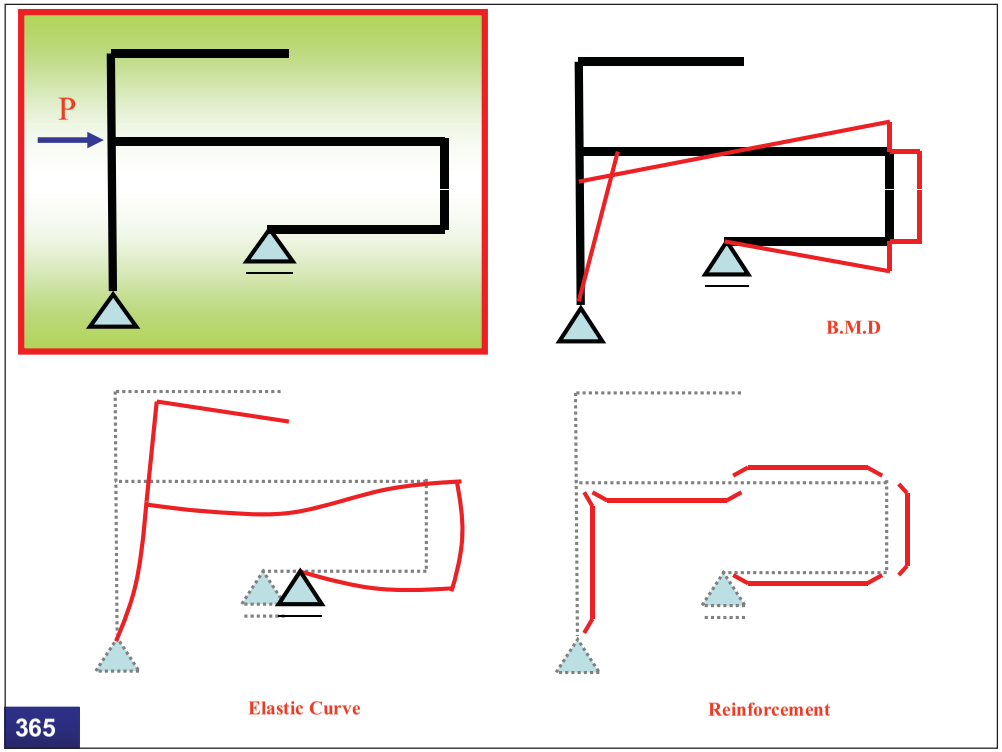
تسليح الضغط او الشد اذا كان هو الموجود فقط يكون فى الاتجاهين

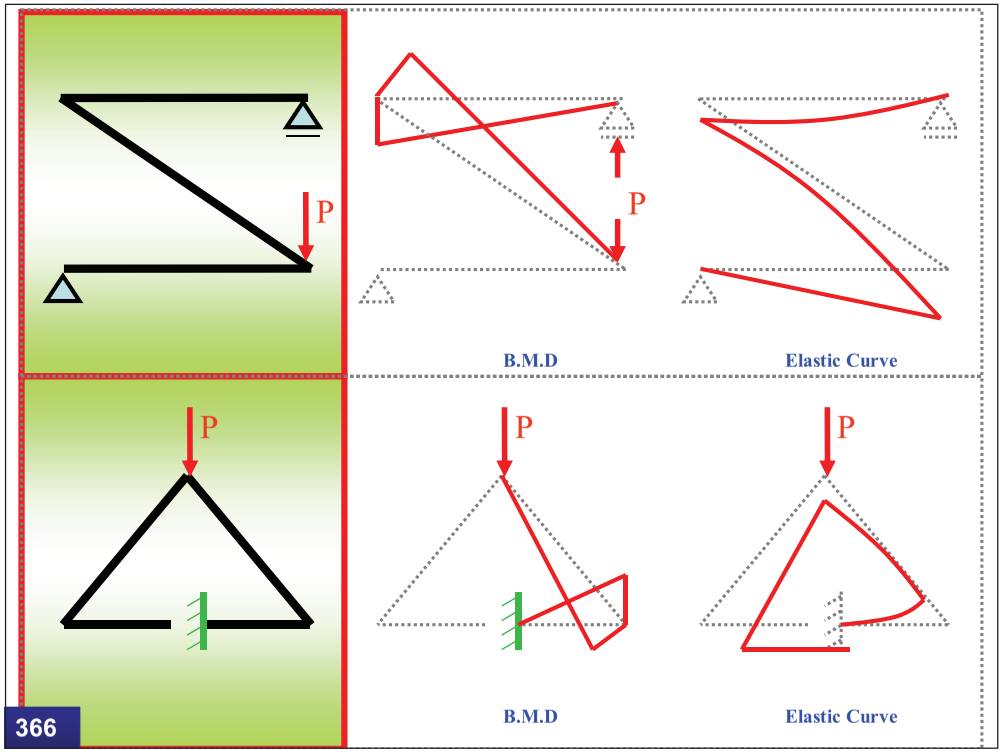

P
ZERO
B.M.D
Elastic Curve
Reinf
P
B.M.D
Elastic Curve
Reinf
P
B.M.D
Elastic Curve
Reinf
P
B.M.D
Elastic Curve
Reinf
361

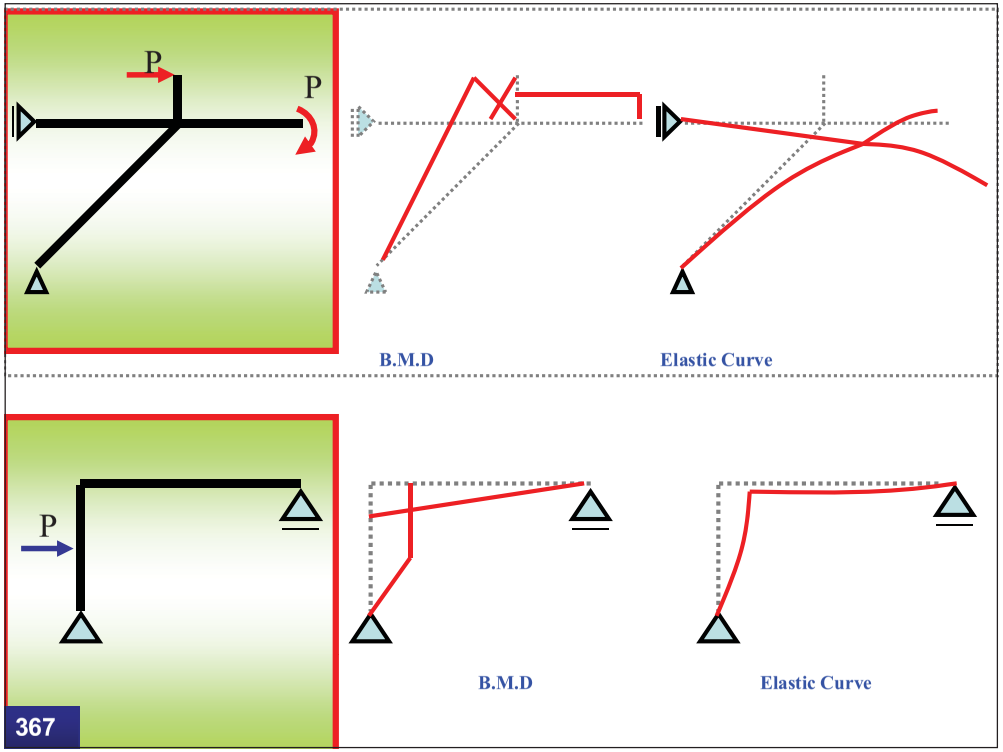

P
B.M.D
Elastic Curve
Reinf
P
B.M.D
Elastic Curve
Reinf
P
B.M.D
tic Curve
Reinf
P
B.M.D
Elastic Curve
Reinf
362

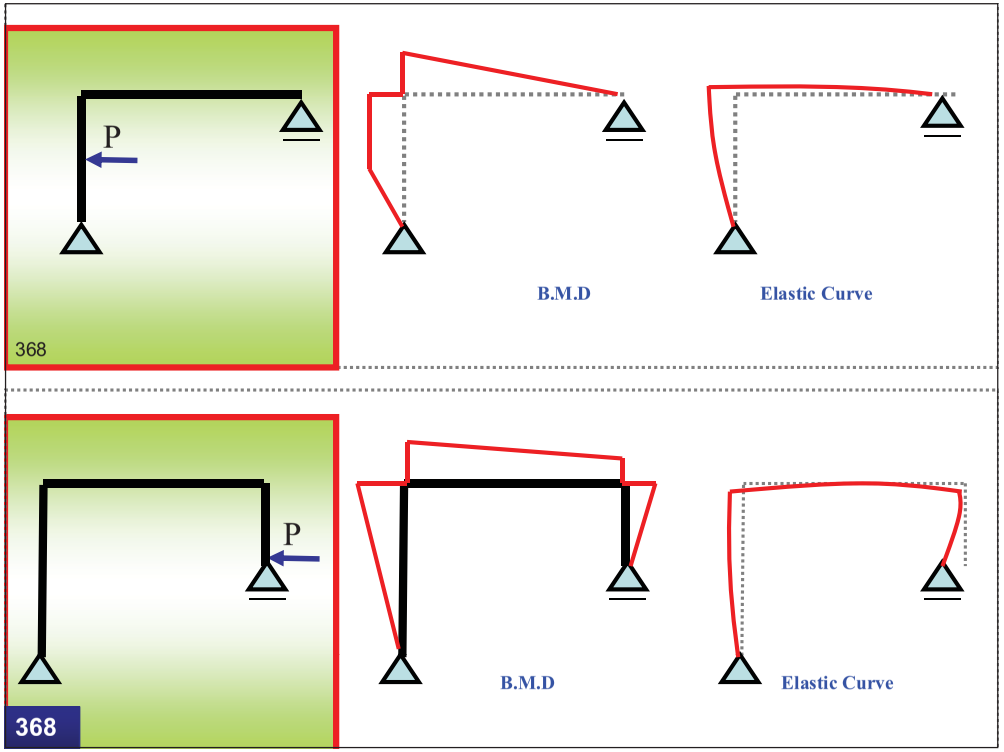

P
B.M.D
Elastic Curve
Reinforcement
P
B.M.D
Elastic Curve
Reinforcement
363


P
B.M.D
P
Elastic Curve
Reinforcement
P
Elastic Curve
P
B.M.D
Reinforcement
364

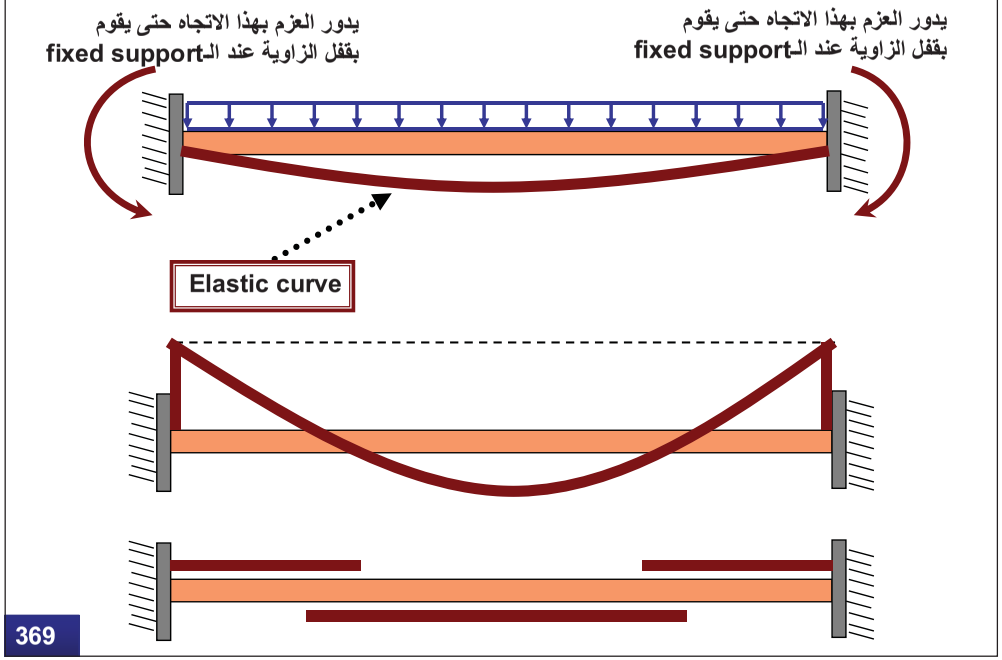

P
B.M.D
Elastic Curve
Reinforcement
365


P
P
B.M.D
Elastic Curve
P
P
P
B.M.D
Elastic Curve
366

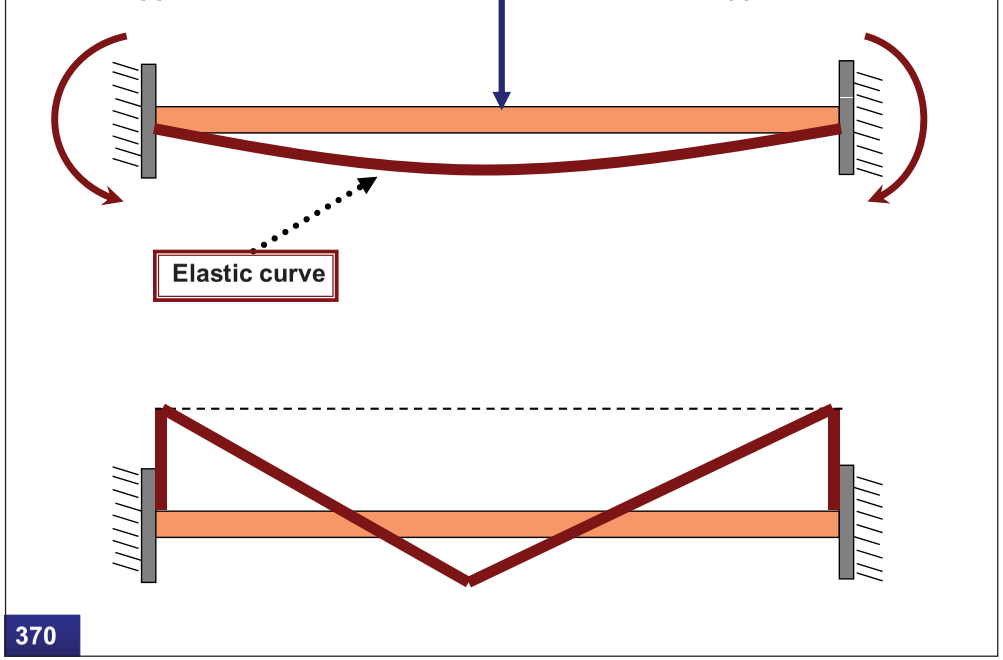

P
P
B.M.D
Elastic Curve
P
B.M.D
Elastic Curve
367


P
B.M.D
Elastic Curve
368
P
B.M.D
Elastic Curve
368

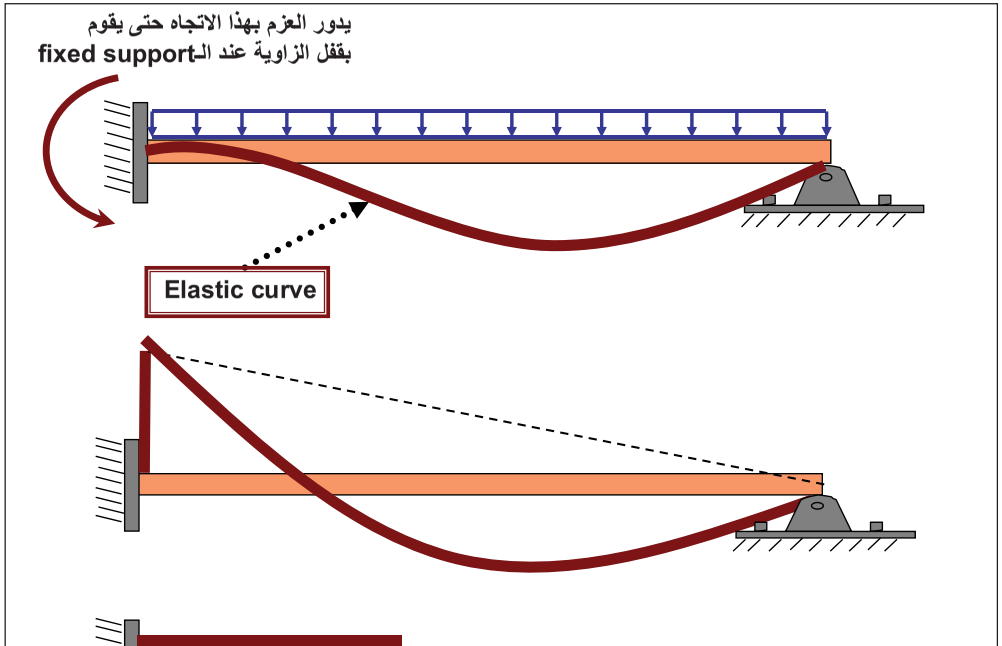
Determinate Structures



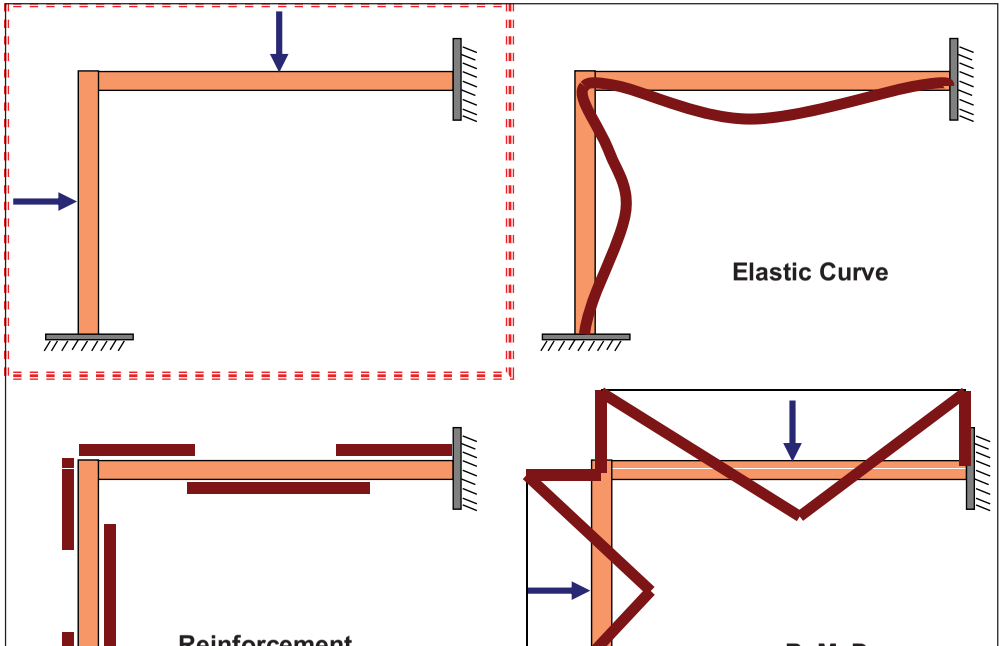
369



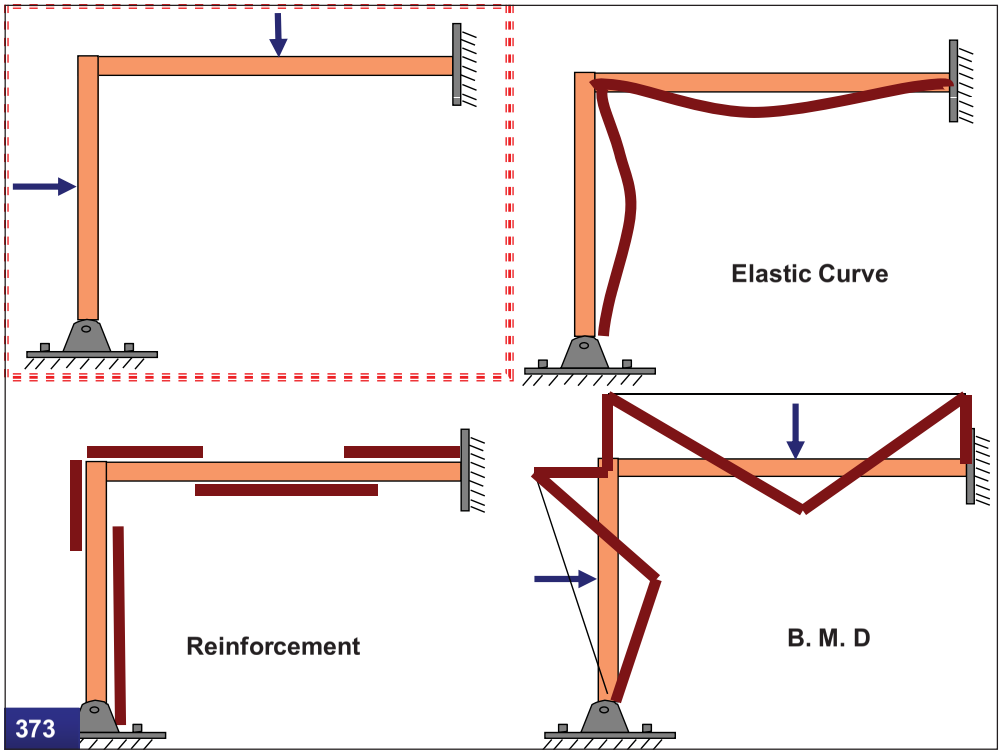
370

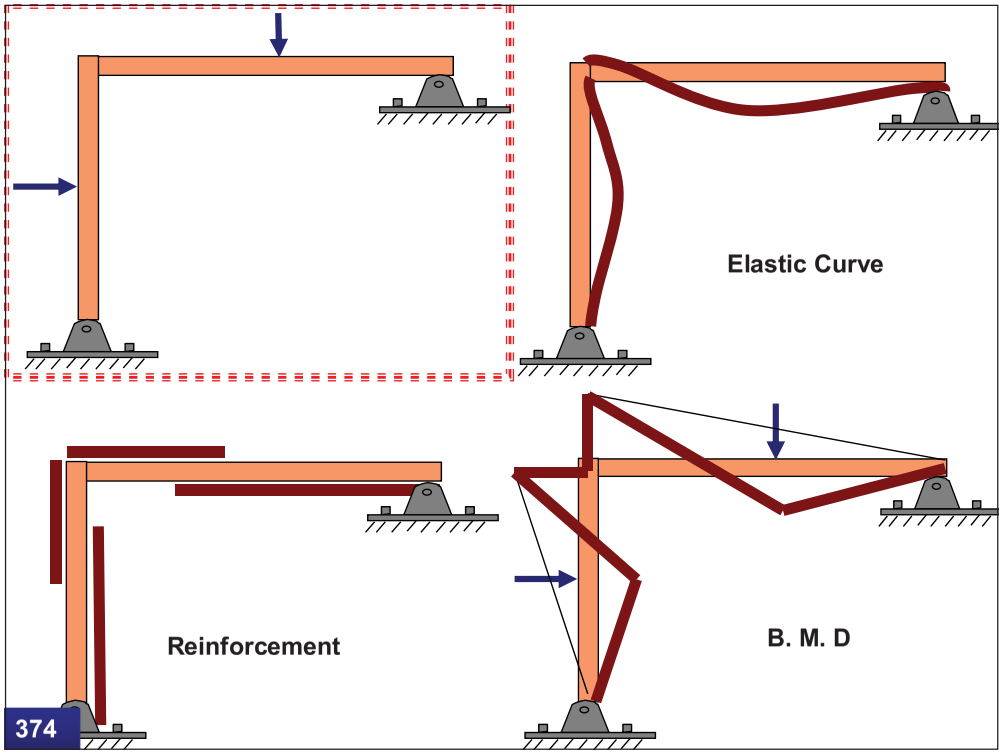


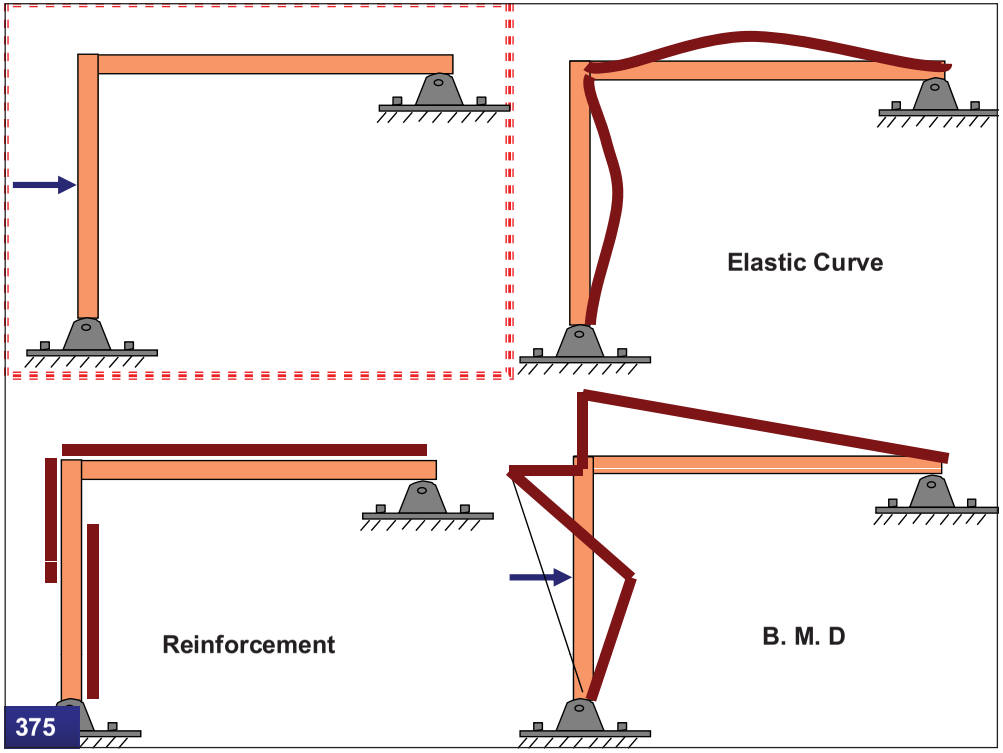
371

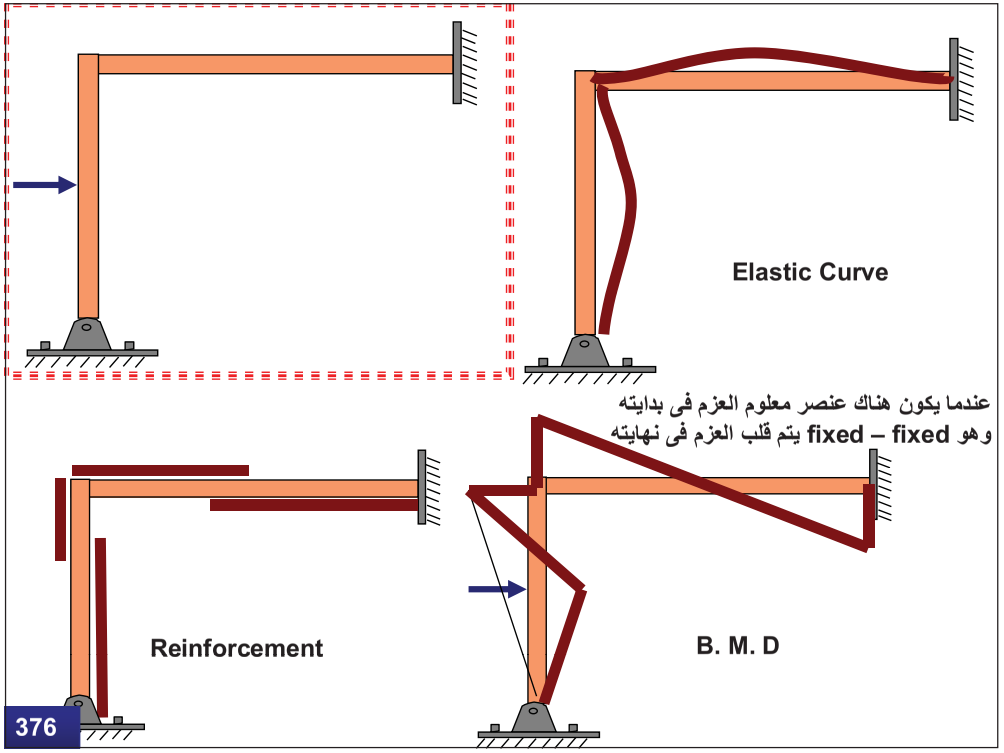


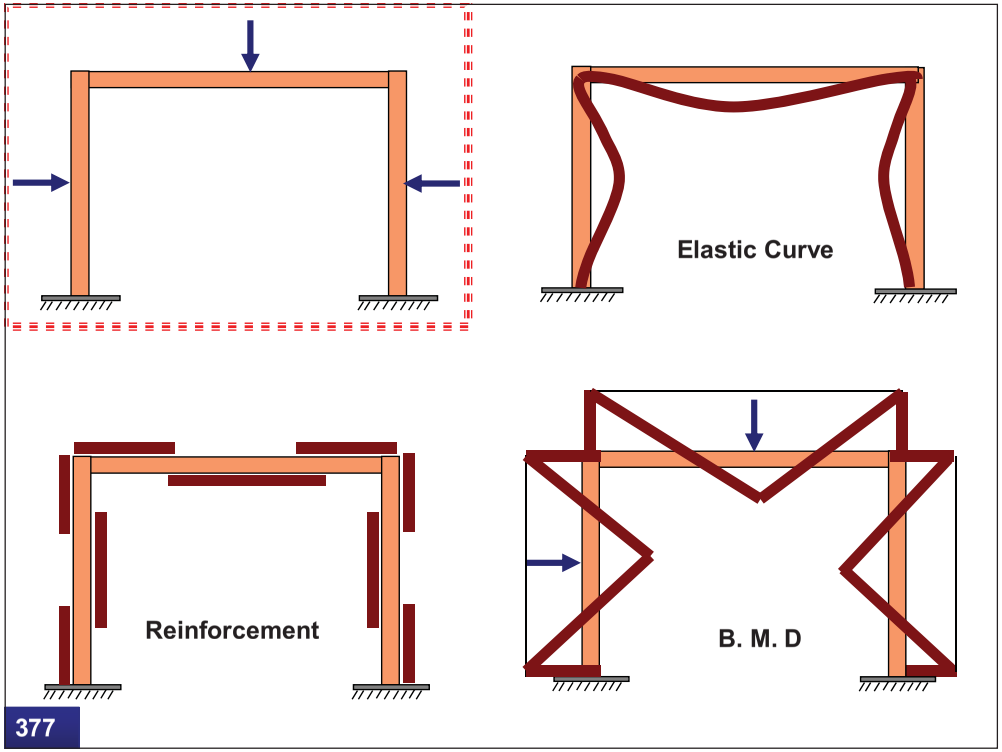
372

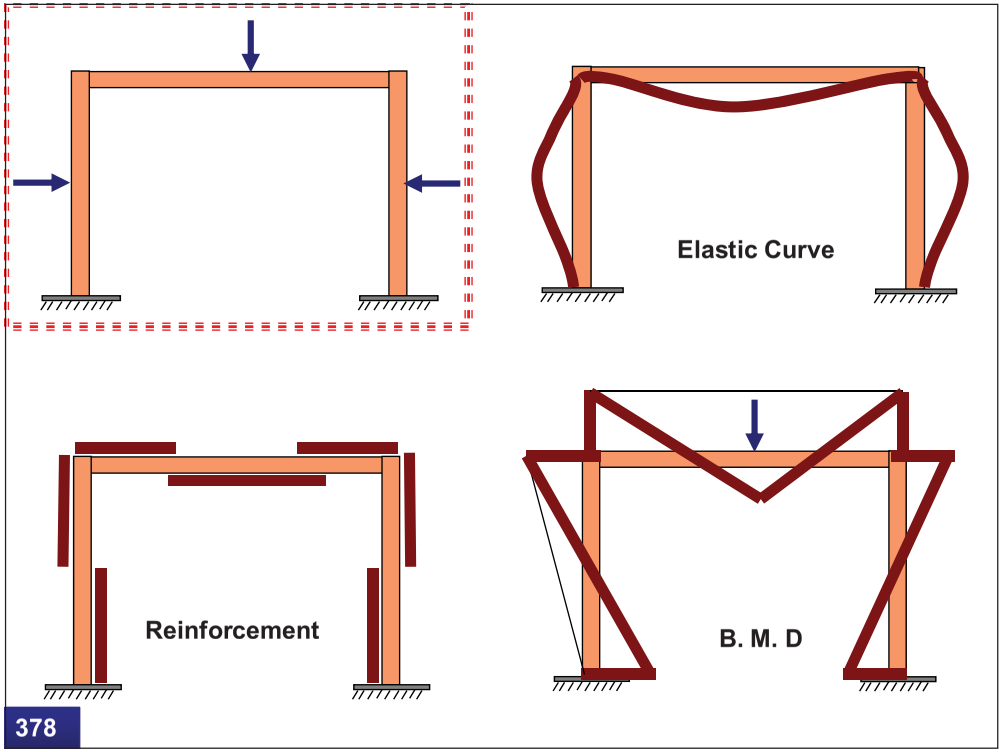

Elastic Curve
Reinforcement
B. M. D
373

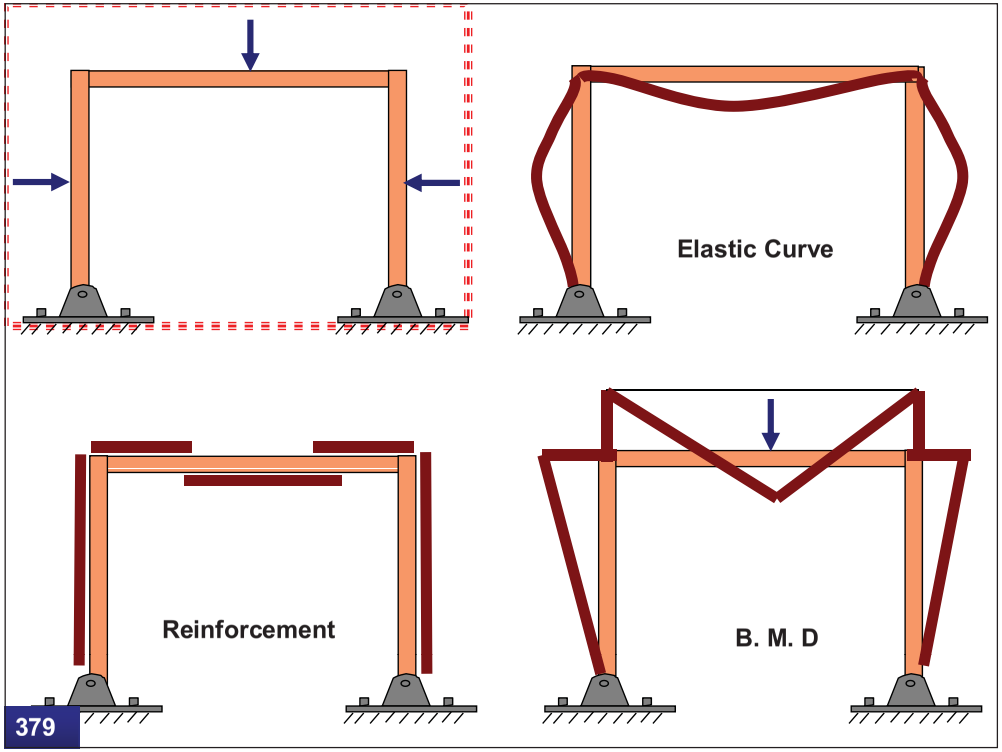

Elastic Curve
Reinforcement
B. M. D
374

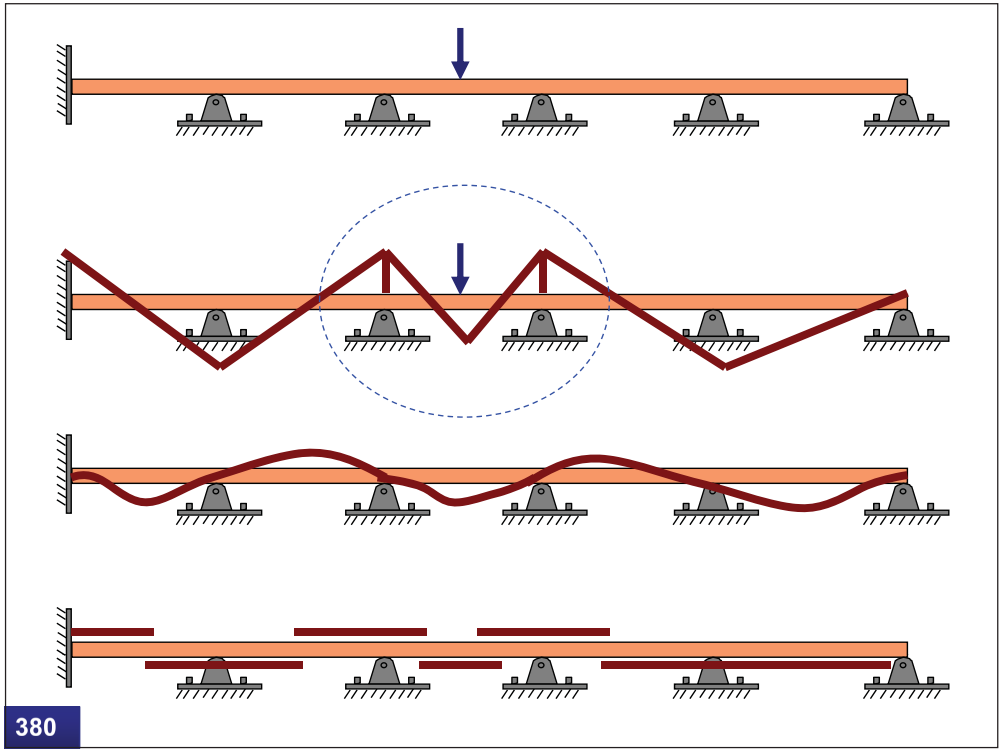

Elastic Curve
Reinforcement
B. M. D
375


Elastic Curve
عندما يكون هناك عنصر معلوم العزم فى بدايته
وهو fixed – fixed يتم قلب العزم فى نهايته
Reinforcement
B. M. D
376

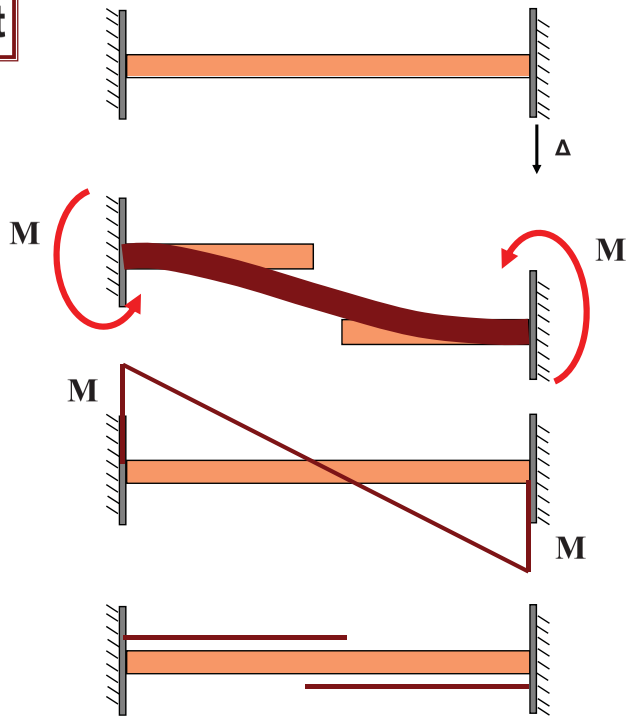

Elastic Curve
Reinforcement
B. M. D
377


Elastic Curve
Reinforcement
B. M. D
378

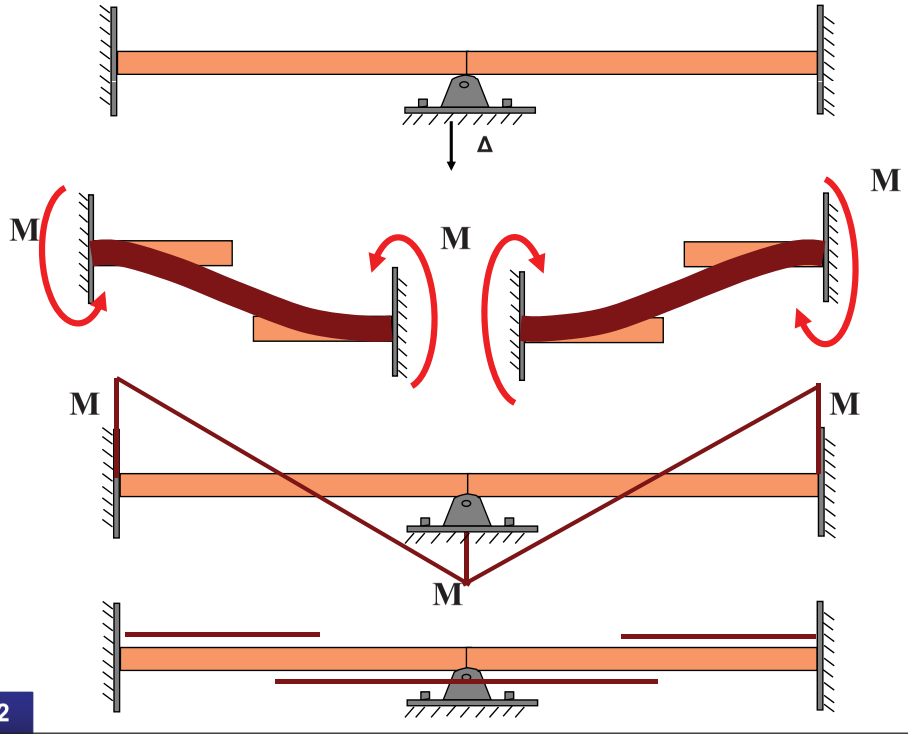

Elastic Curve
Reinforcement
B. M. D
379


380

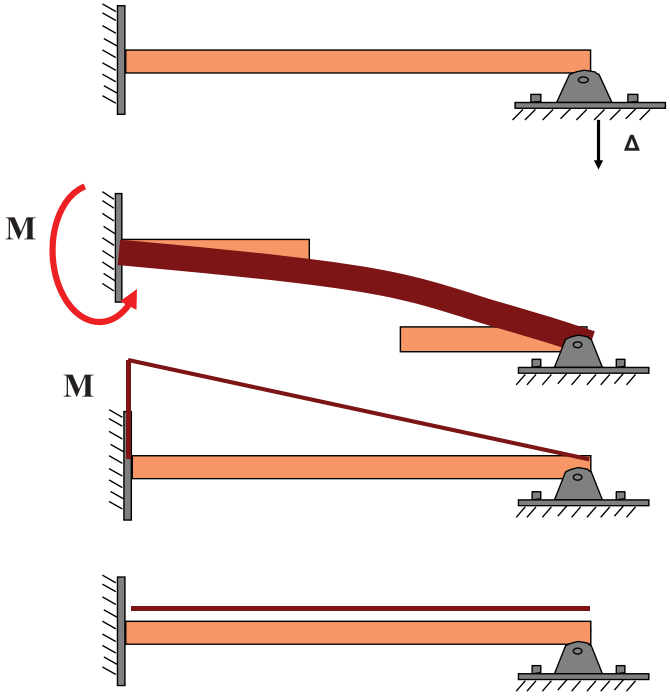
Settlement



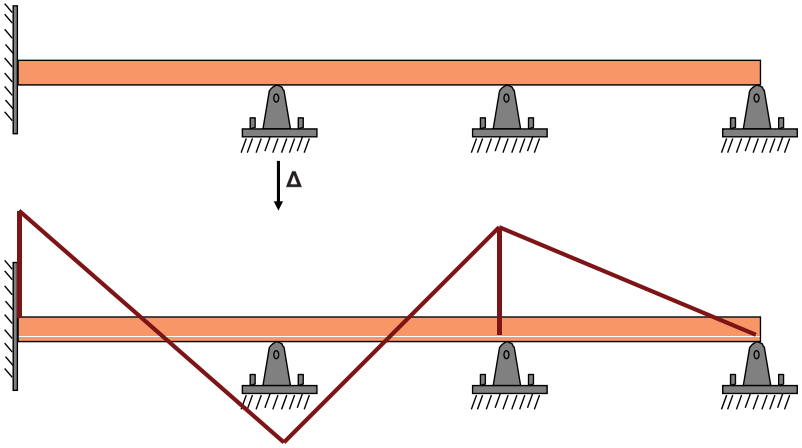
381



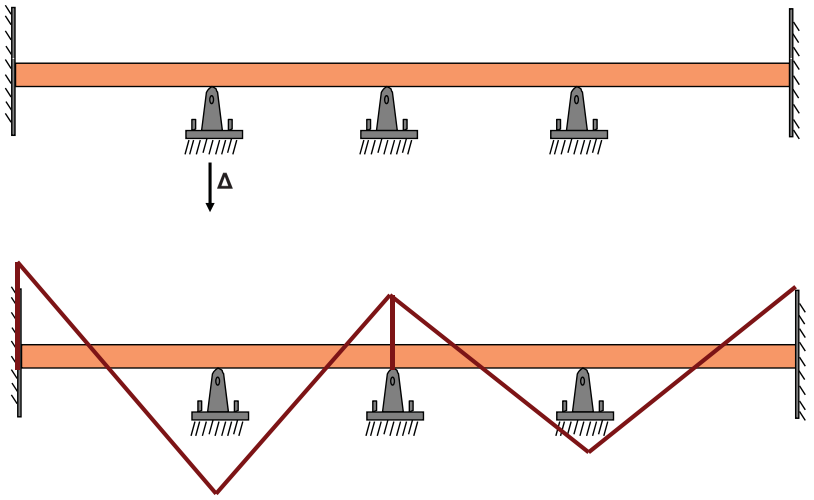
382



383



384



385

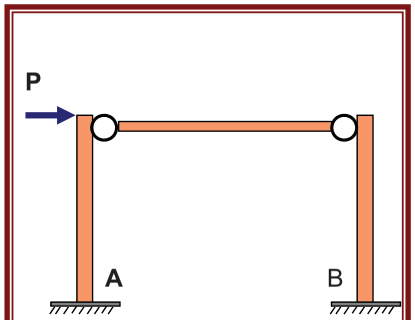
Final 2009

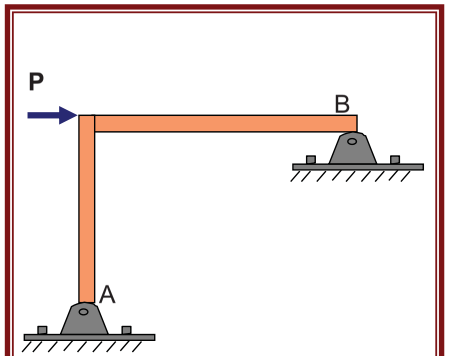
For the following two shapes draw B.M.D, reinforcement and elastic curve due to:

(a) given loads.

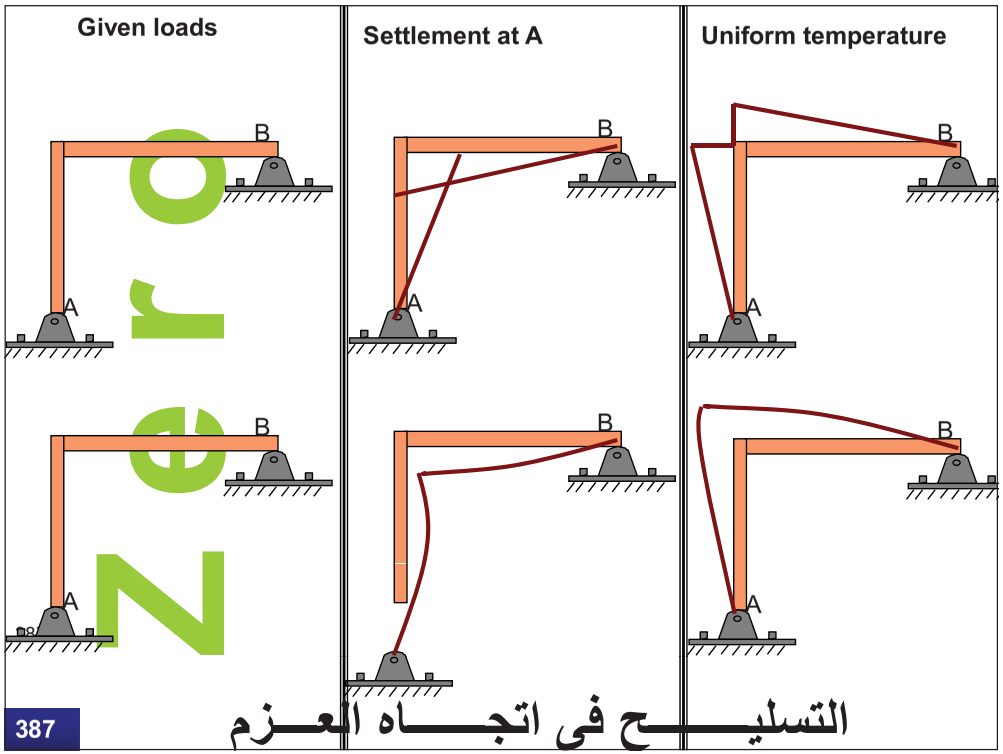
(b) settlement at A.

(c) uniform rise in temperature.

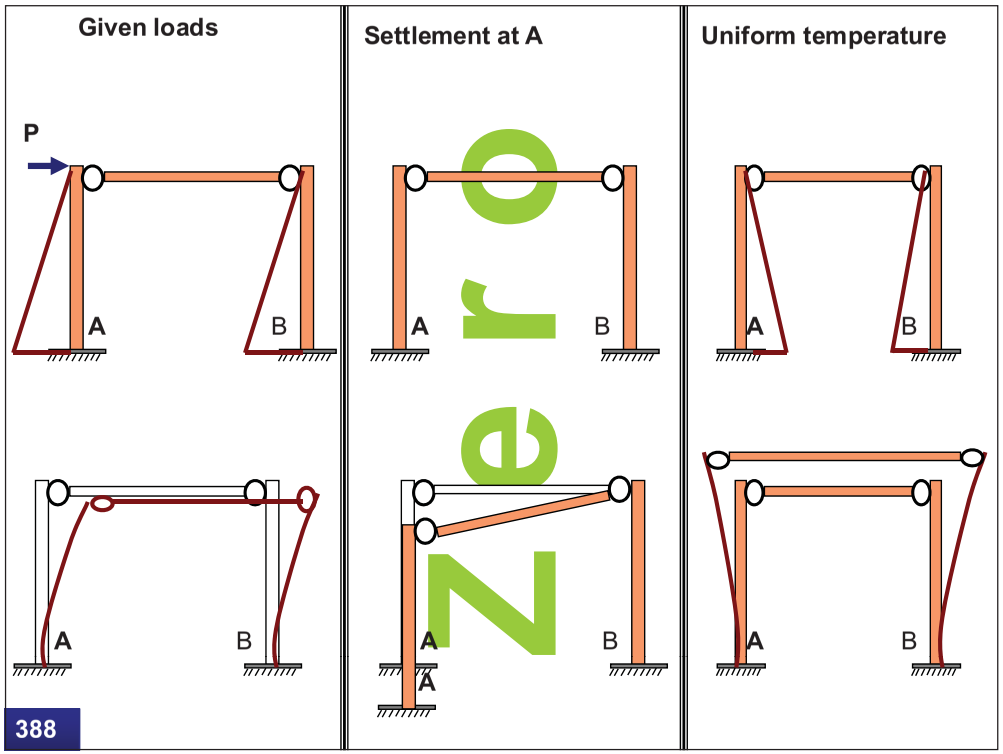




386



387



388

الحمـــــــد لله الذى هدانـــــا للاســـلام
ولـــولا اللـــــــــــه لمـــا إهتدينـــــــا

الحمـــــــد لله الذى وفقنـــــا لهذا العمل
واتمنى من الله ان ينفعنا به بعد الممـــــات

واتمنى من الله ان يوفق كل المهندسين لما يحبه الله ويرضاه